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MACKENZIE VALLEY PIPELINE INQUIRY

Government  
Publications

IN THE MATTER OF APPLICATIONS BY EACH OF

- (a) CANADIAN ARCTIC GAS PIPELINE LIMITED FOR A RIGHT-OF-WAY THAT MIGHT BE GRANTED ACROSS CROWN LANDS WITHIN THE YUKON TERRITORY AND THE NORTHWEST TERRITORIES, and
- (b) FOOTHILLS PIPE LINES LTD. FOR A RIGHT-OF-WAY THAT MIGHT BE GRANTED ACROSS CROWN LANDS WITHIN THE NORTHWEST TERRITORIES,

FOR THE PURPOSE OF A PROPOSED MACKENZIE VALLEY PIPELINE

and

IN THE MATTER OF THE SOCIAL, ENVIRONMENTAL AND ECONOMIC IMPACT REGIONALLY OF THE CONSTRUCTION, OPERATION AND SUBSEQUENT ABANDONMENT OF THE ABOVE PROPOSED PIPELINES

(Before the Honourable Mr. Justice Berger, Commissioner)

Yellowknife, N.W.T.,

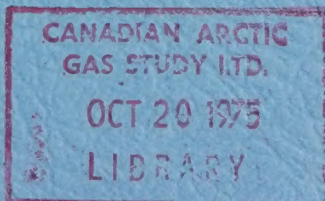
October 16, 1975.

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PROCEEDINGS AT INQUIRY

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Volume 73





MACKENZIE VALLEY PIPELINE INQUIRY

IN THE MATTER OF APPLICATIONS BY EACH OF  
(a) CANADIAN ARCTIC GAS PIPELINE LIMITED FOR A  
RIGHT-OF-WAY THAT MIGHT BE GRANTED ACROSS  
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PROCEEDINGS AT INQUIRY

Volume 73



APPEARANCES:

Mr. Ian G. Scott, Q.C.  
Mr. Stephen T. Goudge,  
Mr. Alick Ryder and  
Mr. Ian Roland for Mackenzie Valley  
Pipeline Inquiry;  
Mr. Pierre Genest, Q.C.  
Mr. Jack Marshall,  
Mr. Darryl Carter, and  
for Canadian Arctic Gas  
Pipeline Limited;  
Mr. Reginald Gibbs, Q.C.  
Mr. Alan Hollingworth for Foothills Pipelines  
Ltd.;  
Mr. Russell Anthony,  
Prof, Alastair Lucas for Canadian Arctic  
Resources Committee;  
Mr. Glen W. Bell and  
Mr. Gerry Sutton for Northwest Territories  
Indian Brotherhood and  
Metis Association of the  
Northwest Territories;  
Mr. John Bayly for Inuit Tapirisat of  
Canada and the  
committee for Original  
Peoples Entitlement;  
Mr. Ron Veale and  
Mr. Allen Lueck for the council for the  
Yukon Indians  
Mr. Carson H. Templeton for Environment Protect-  
ion Board;  
Mr. David Reesor for Northwest Territories  
Association of Muni-  
cipalities  
Mr. Murray Sigler for Northwest Territories  
Chamber of Commerce

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CANADIAN ARCTIC  
GAS STUDY LTD.

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## WITNESSES FOR CANADIAN ARCTIC GAS PIPELINE LIMITED:

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Yellowknife, N.W.T.

October 16, 1975.

(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

THE COMMISSIONER: Well, are we ready to begin today, Mr. Goudge?

MR. GENE ST: Mr. Commissioner, I'd like to raise a problem having to do with the order of evidence. When we broke yesterday, Mr. Marshall was cross-examining Dr. Adam and as you pointed out, sir, Dr. Adam will be returning at a later date. I have, sir, assembled a geotechnical panel consisting of Dr. Clark, Dr. Morgenstern, Dr. Slusarchuk, Dr. Harlan and Dr. Hoekstra, who will be a new witness, and the main purpose of this is to rebut the evidence of Dr. Williams and deal with the questions that you were raising yesterday in the course of the proceedings.

We would like to defer our cross-examination -- any further cross-examination of Dr. Adam. We have problems, I understand from Mr. Goudge first of all that the issues raised in this frost heave business are quite fundamental. I regard them as the principal issue raised in Phase 1. I understand from Mr. Goudge that he would like some time between the giving of the evidence in chief of these people and his cross-examination of them so that he can have an opportunity to get advice, for instance, from Dr. Williams.

We are very anxious, sir, to put this evidence forward, at least the examination in chief, and Dr. Morgenstern has some rather rigid commitments tomorrow in Alberta, and I would like to





propose, sir, as far as we're concerned anyway that we be given leave to defer our further cross-examination of Dr. Adam until his return, that we be given an opportunity to rebut strictly what Dr. Adam said at a later date, and so that we can be enabled to put on the geotechnical panel on the issue of frost heave and complete the examination in chief hopefully today.

I understand that Mr. Templeton is not in agreement with that procedure. I don't know what Mr. Goudge's position is.

MR. GOUDGE: Sir, I may say obviously because of the nature of the complexity of the issues we deal with in this Inquiry, and the variety of witnesses, that the parties seek to bring before you there is no doubt that we do have logistic problems of the kind that Mr. Genest is raising. That's on the one hand.

On the other hand, there is no doubt that Dr. Adam is here really at my request to complete his cross-examination this week, and other things being equal, I had hopes that we would have been able to accomplish that this week. He will, as we've heard, be back as part of the Environment Protection Board panel, and for that we're grateful. I may say I take no position on the issue raised except to say that I can understand the difficulties that Mr. Genest has on the one hand, and the concern Mr. Templeton has on the other hand, that Dr. Adam be dealt with in full if possible this week, subject to the questions that Mr. Gibb's client may have later on.





THE COMMISSIONER: Well, excuse me, if this panel of Mr. Genest's were to give evidence today, you wouldn't be ready to cross-examine until a later time to be arranged. Dr. Morgenstern would not be able to be here tomorrow anyway, I gather.

MR. GOUDGE: No doubt about that, sir. Mr. Genest is perfectly correct.

THE COMMISSIONER: So Dr. Adam is unfortunately the person who is, so to speak, most inconvenienced by this.

MR. GOUDGE: Yes sir.

THE COMMISSIONER: Do you want to say anything about this, Mr. Templeton?

M R. GENEST: Perhaps before Mr. Templeton gets up, sir, we are prepared to proceed tomorrow with Dr. Adam, if it wouldn't be an inconvenience for him to stay over. I understand he has to come back -- at least you've given the opportunity to Foothills to ask him back. I merely wanted to add that.

THE COMMISSIONER: Do you want to say anything, Mr. Templeton? You're entitled to.

MR. TEMPLETON: Well, Mr. Commissioner, I think it's a little unusual to interrupt the -- he was brought here for cross-examination, for the testimony he gave in June, and we all have logistic problems. I, too, have one tomorrow. I didn't object last time, when Mr. Dau was put on ahead because it was more convenient for him.

THE COMMISSIONER: Excuse me, when was that?



MR. TEMPLETON: In the transcript, page 10128, line --

THE COMMISSIONER: When was it?

MR. TEMPLETON: It was on September 24th.

THE COMMISSIONER: Just what happened then?

MR. TEMPLETON: Well, it was rather a small thing but I was brought up again for cross-examination and Mr. -- it was more convenient for Mr. Dau to go on, and I think Mr. Genest even quoted me as agreeing which wasn't even discussed with me, and there's an old Winnipeg proverb, I suppose if you get misquoted once, shame on you; but if you get misquoted twice, shame on me.





1 But I will accept,  
2 of course, Commission Counsel's ruling who has logistic  
3 problems from everybody so we will accept that.  
4 I think it is rather unusual to interrupt the middle  
5 of a cross-examination that he was brought here for  
6 and we had done -- had a considerable number of people  
7 at our own expense trying to get out all the information  
8 from the testimony so that he could relate all this  
9 material of the highway, geotechnical information and  
10 everything else and to say, well, I guess we will dispense  
11 with this now and go on to -- you can come back at a  
12 later date, sometime in March or whatever.

13 However, I will accept Mr.  
14 Goudge's ruling.

15 MR. GOUDGE: I don't make  
16 rulings, sir.

17 MR. RAYLY: Mr. Commissioner,  
18 this isn't one of my witnesses, so in that sense it  
19 isn't a direct concern from my logistics, but one thing  
20 does concern me and that is that Arctic Gas has been  
21 cross-examining Dr. Adam on a matter of Dr. Williams'  
22 evidence. They now propose to call a panel in the middle  
23 of their cross-examination, I suspect to discuss  
24 those things that they are already discussing with  
25 Dr. Adam and to have him come back and say what do you  
26 think about that.

27 That is a very strange way  
28 of doing --

29 THE COMMISSIONER: It may be  
30 strange, but it is in a sense almost doing a favour





1 to Dr. Adam. He will hear what they have to say before  
2 he is asked any further questions on the subject if the  
3 procedure that Mr. Genest wants me to pursue is the  
4 one that --

5 MR. BAYLY: I understood  
6 that to be a concern of Mr. Templeton, that it was  
7 being done in that fashion sort of in mid-flight of  
8 Dr. Adam. Perhaps it is to his advantage, but Mr.  
9 Templeton didn't seem to think so earlier this  
10 morning or am I misquoting you again?

11 THE COMMISSIONER: The  
12 third time. Shame on both of you.

13 Well, I got the impression  
14 yesterday that Mr. Marshall had virtually completed  
15 his cross-examination on the Williams' theory, or the  
16 Williams' critique of the Arctic Gas frost heave position  
17 so I think it is logical to hear this panel today.  
18 That is my reason for going along with Mr. Genest. I  
19 am concerned about the logistics, but everybody seems  
20 to have logistical problems getting here and then  
21 getting to wherever their next stop is. I think  
22 since you have these people here and since we are  
23 right in the thick of this frost heave thing and since  
24 occasionally I have the feeling that I understand it,  
25 I think we should go ahead. I would like to hear  
26 these people now before the whole thing slips away  
27 from me again. I think we will do that and if  
28 Dr. Adam can remain until later today or tomorrow  
29 whenever this panel's evidence in chief is finished  
30 we could go on with him. If he can't remain I quite





1 understand that he is a busy man and then the cross-  
2 examination of Dr. Adam would have to be postponed until  
3 he returns with the Environment Protection Board, but  
4 there is no reason for anyone to get terribly upset  
5 about that. In any sort of hearing you have to jump  
6 around, or as Mr. Genest said, bounce up and down with  
7 the witness --

8 I should say I am not really  
9 concerned that we don't follow the rules as we might  
10 in a court case. There you are trying to reconstruct  
11 what occurred in the past and someone is reluctant  
12 to testify or the order in which testimony is given  
13 might have a real reluctance to testify or producing  
14 a document or evidence late in the day might be thought  
15 of as going to credibility, but the order of testimony  
16 might well affect the way in which the evidence --  
17 the way which the evidence is given. Here we  
18 are trying to predict what is going to happen and  
19 allowing everybody an extra crack at this thing, which  
20 I fully intend to do, even if it means the replying  
21 to what somebody else said in replying to somebody  
22 else who is replying to somebody else and that is not  
23 an exaggeration of the procedure we may wind up  
24 following here. We may see Dr. Williams back again  
25 here because I was going to say, Mr. Goudge, that  
26 it seems to me that you should send to him the trans-  
27 script of everything that has been said here since  
28 he left and get his comments sent to you and then  
29 Mr. Scott and you with consultation with Dr. Fyles  
30 can decide whether you think you ought to apply to have  
him recalled.





Clark, Morgenstern, Slusarchuk,  
Harlan & Hoekstra  
In Chief

Because I should think it's as much in the interest of Arctic Gas and Foothills to get to the bottom of this as it is in the interest of the Inquiry. They don't want to build this thing if they finally are given the right to build it, to find that they have under-estimated seriously this phenomenon.

All right, well you ask this panel to come up to the --

MR. GENEST: All of them, that is Doctors Clark, Morgenstern, Slusarchuk and Harlan have previously been sworn. Dr. Hoekstra, sir, is a new witness and perhaps he could be sworn. Could I ask the panel to take their places?

JOHN IVOR CLARK,  
N.R. MORGENSTERN,  
W.A. SLUSARCHUK,  
R.M. HARLAN, resumed:  
PIETER HOEKSTRA, sworn:

MR. GENEST: I have a statement of Dr. Hoekstra's background and experience which I would ask leave to file, sir. His name is Dr. Pieter, P-I-E-T-E-R Hoekstra, H-O-E-K-S-T-R-A.

DIRECT EXAMINATION BY MR. GENEST:

Q Dr. Hoekstra, just as soon as you close your brief case so I can see you, --

THE COMMISSIONER: Dr. Hoekstra has been known until now Dr. Hoekstra as Hoekstra as if were some legendary figure like Terragazzi.

MR. GENEST: Q Dr. Hoekstra, you're now employed as a senior geophysicist for





Clark, Morgenstern, Slusarchuk,  
Harlan, Hoekstra  
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Northern Engineering Services Company Limited?

A Yes.

Q And you received what is called on your resume as the equivalent of a Bachelor of Science at some unpronouncable Dutch name, at the University of Wageningen in the Netherlands. You have a Master of Science from McGill University in Montreal specializing in soil physics and physical chemistry. Is that correct?

A That's correct.

Q And you received a doctor's

--

THE COMMISSIONER: Just before we go on, can I have a copy of whatever it is you're reading from?

MR. GENEST: I am sorry I thought Mr. Marshall had done the paper route. We overlooked our most important customer.

Q As to your professional affiliation, sir, you're a member of the American Geophysical Union, a member of the Society of Exploration Geophysicist .

A Yes.

Q A member of Sigma Xi, that is a professional fraternity, is it?

A Yes.

Q A member of the United States Committee on Permafrost with the National Academy of Sciences.

A Correct.



Clark, Morgenstern, Slusarchuk,  
Harlan, Hoekstra  
In Chief

Q And you're an advisor for the Canada Centre for Remote Sensing, being a work group on soil moisture relating to that organization.

A That is correct.

Q Then, sir, from 1963 to 1975 you were employed as a research geophysicist for the Corps of Engineers of the U.S. Army, in the Cold Regions Research & Engineering Laboratory of that organization, and you conducted research, testing and equipment development in the following areas: Heat and mass transport in ground, frost heaving electrical properties of ground, unfrozen water in frozen ground, shock wave propagation in frozen ground, sea ice physics, microwave attenuation in ground, electromagnetic propagation over and in the earth. Is that correct?

A That's correct

Q And with the U.S. Army Corps of Engineers you were in charge of their test program to obtain radar scattering parameters for snow and ice surfaces for terrain avoidance radars. You're also in charge of the ground and airborne geophysical exploration for mapping permafrost and rock type in Fairbanks, Alaska. You're in charge -- you are involved in the geophysical exploration program for the proposed Tennessee-Tombigbee Waterway.

A Yes.

Q Going over, sir, to page 2, you were involved in the electrical resistivity mapping of the entire Alaska Oil Pipeline for corrosion





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Harlan, Hoekstra  
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protection, is that correct?

A That's correct.

Q You're involved in geophysical exploration as pump-stations on the Alaska Pipeline -- that's the Alyeska line.

A Alyeska Pipeline, yes.

Q And also for the geophysical exploration for borrow sources, overburden and rock type at the proposed Dickey Lincoln Hydro-electric Dam in NorthKern Maine. Is that correct?

A That's correct.

Q In 1968 you were visiting professor at the University of Illinois.

A Correct.

Q In 1972 you were secretary of the Army Research & Study Fellowship at the Laboratory of Electro-magnetic Theory, Technical University of Denmark, is that right?

A I was away from the Cold Region Laboratories for a year, yes, that is correct.

Q And you worked with a group on radar echo sounding of the Greenland Ice Cap.

A That's correct.

Q And in 1974 you were a member of NASA, that's the National Aeronautic Space Administration --

A That's correct.

Q -- a group to plan research and development programs in active microwave

HALLAM,  
in Chief

A That's correct.

Q You're involved in des-

physical exploration as pump-stations on the Alaska

pipeline -- that's the Alyaska line.

A Alyaska Pipeline, yes.

Q And also for the trans-

cal exploration for borrow sources, overburden and rock

type at the proposed Bitter Lake Hydro-electric Dam

in Northern Maine. Is that correct?

Q In 1968 you were visiting

professor at the University of Minnesota.

A Correct.

Q In 1972 you were with the

of the Army Research & Engineering Development at the University

of Electro-magnetic Theory, Technical University

A I was away from the College

Region Laboratories for a year, yes, that is correct.

Q And you worked with a

group on radar echo sounding of the Greenland ice sheet.

A That's correct.

Q And in 1971 you were

member of NASA, that's the National Aeronautics and Space

A That's correct.

Q -- a group to study

current programs in active microwave



Clark, Morgenstern, Slusarchuk,  
Harlan, Hoekstra  
In Chief

sensors.

A Correct.

Q And in 1975 you became a senior geophysicist with R.M. Hardy & Associates, and were seconded to Northern Engineering Services Company Limited.

A That's correct.

Q And sir, attached to your resume which I would like to file as an exhibit -- perhaps I could let Miss Hutchinson have my copy -- is a schedule -- a lengthy list of publications of which you have been the author. Is that correct?

A And co-author.

Q And in particular, sir, you're the author of a study that was referred to in Dr. Williams' evidence as one of the bases on which he has reached his conclusions.

A Right, the second article under the publication on "Frost Heaving in Frozen Ground."

Q That's entitled:

"Water Movement and Freezing Pressures, Soil Science --"

A

"Society of American Proceedings, Volume 33."

Q Thank you. Now, Mr.

Commissioner, I'd like to deal at the outset with these witnesses with some of the questions you raised rather directly yesterday to get their position quite clearly on the record. They will be elaborated during the course



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of the examination in chief.

Gentlemen, perhaps I could address this to Dr. Clark or the panel in general, as I understand -- perhaps you can tell me if this is correct -- Dr. Williams' thesis, it is that a chilled pipeline, such as that proposed by Arctic Gas, is going to produce many times more heave than our evidence predicts, and that we will not be able to suppress this heave with types of burial or surcharging that we propose. Is that a proper statement of what you understand was the main thesis of Dr. Williams?

WITNESS CLARK: That's our understand of what his evidence presented.

Q Now, do you agree with that thesis?

A No, we don't agree with that thesis.

(RESUME OF DR. HOEKSTRA & LIST OF REPORTS

MARKED EXHIBIT 281)





1 Q Now, having got your  
2 disagreement on the record, let us lay it aside for  
3 a moment and assume that it is correct. If Dr.  
4 Williams is correct in his thesis, in your opinion,  
5 can Arctic Gas proceed with a chilled buried pipeline  
6 that is presently proposed?

7 A No, they could not.

8 Q And why is that, sir?

9 A It would involve, for  
10 a buried pipeline, massive berms or tunneling which  
11 in our opinion would not be feasible.

12 Q And if I may deal with  
13 a subsidiary question raised by Mr. Commissioner  
14 yesterday which relates to the particular problem at  
15 river crossings. What about the application of Dr.  
16 Williams' theory in respect to river crossings? Does  
17 it create any different problems?

18 A Yes, he identifies or  
19 picks as a specific example of a problem area, river  
20 crossings, where all the conditions are present for  
21 the types of frost heave that he postulates. Our  
22 position is that the conditions at river crossings  
23 obviously are different than the overland frost heaving  
24 problem but the mitigative measures or preventative  
25 measures, if you like, that we have conceived, we feel  
26 are as appropriate for river crossings as they are  
27 anywhere else.

28 Q So if Dr. Williams is  
29 right, you can't cross rivers in the manner in which  
30 you propose.





Clark, Morgenstern, Slobarchuk,  
Farlan, Hoekstra  
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1 A Not in the manner in which  
2 we propose.

3 Q Then, sir, could I ask  
4 you if you accept the proposition that the views  
5 expressed by Dr. Williams on frost heave are more  
6 widely held among experts in this field than the  
7 views held by Arctic Gas or by Northern Engineering  
8 Services?

9 WITNESS MORGENSTERN:

9 A I would not agree with  
10 that. I think the views held by Northern Engineering  
11 are the more common views perhaps because most of  
12 the experts in the field may be associated with the  
13 project. The views as we interpret Dr. Williams'  
14 are quite singular. His position seems unique in the  
15 literature.

16 Q Then may I ask if Dr.  
17 Williams' is correct in his thesis and his evidence  
18 was addressed mainly to the problem in the area  
19 of discontinuous permafrost. If his concern in that  
20 area is correct, is it applicable as well in the area  
21 of continuous permafrost?

22 WITNESS CLARK:

23 A Yes, the concern that  
24 he expressed relative to the discontinuous permafrost  
would apply equally to frozen ground, in other words,  
the heaves that he says will occur would occur in  
ground that is already frozen as well as unfrozen  
ground.

Q So that if he is right  
then we can conclude that the concept of a buried ch.



1 pipeline is not practical either in the ground -- either  
2 in the area of continuous permafrost and the area  
3 of discontinuous permafrost.

4 A If one accepted his  
5 concept that would be the case.

6 Q Then finally, as a  
7 preliminary question, may I raise again a concern  
8 stated by Mr. Commissioner yesterday. I think it  
9 was in these terms, are we not better to deal with  
10 the devil that we know, that is, thaw settlement, than  
11 the devil that we don't know, that is, frost heave?

12 WITNESS MORGENSTERN:

13 A I have had a fair amount  
14 of experience with problems of thaw settlement. I  
15 would suggest that they are both devils, in perhaps  
16 equal regard. The problem of allowable thaw  
17 settlement requires a predictive ability, a knowledge  
18 of terrain, a detailed soil/pipe interaction and the  
19 same is equally true of the problem of frost heave.  
20 One has to understand the processes, have some predic-  
21 tive ability, undertake a detailed soil/pipe interaction  
22 to design under these conditions.

23 It is a question of amount,  
24 perhaps economic and so on as to which problem one  
25 would want to face at any particular time. I would  
26 hate to generalize on that basis. It is a matter of  
27 site specific conditions whether you choose to cross  
28 a certain component of the terrain warm or whether  
29 you choose to cross it cold.

30 Q I think your evidence





Clark, Morgenstern, Slusarchuk,  
Harlan, Hoekstra  
In Chief

1 chief, well, let's take the area, the clear area of  
2 continuous permafrost --

3 A There is no question  
4 in my mind that one would cross that cold, buried  
5 cold. Crossing that buried warm would create quite  
6 severe problems for a pipeline in the ice-rich terrain  
7 that one would have to cross. Some parts of the  
8 permafrost one could cross warm in which the permafrost  
9 doesn't have very much ice, of course if it is rock,  
10 or if it is gravel or things of that kind, but  
11 normally our vision of difficult frost settlement  
12 problems in continuous permafrost arise in conjunction  
13 of ice-rich materials.

14 Q And what is your view,  
15 Dr. Morgenstern, as to the state of knowledge of the  
16 problems of frost heave versus, and the design measures  
17 available to deal with it, versus the design measures  
18 and the state of knowledge relating to thaw settle-  
19 ment?

20 A There has been a great  
21 deal of experience handling frost heave problems in  
22 engineering, though not of course this specific problem  
23 that we are dealing on this project. On the other  
24 hand predicting and handling thaw settlement problems  
25 is relatively recent. I wouldn't like to say that one  
26 is much more advanced beyond the other.

27 Q Dr. Clark, let me  
28 ask, while it occurs to me. I think you were quoted  
29 perhaps more than twice, in Mr. Templeton's term by  
30 Mr. Commissioner as using the adjective, "horrendous" in



Clark, Morgenstern, Slusarchuk,  
Harlan, Hoekstra  
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1 connection with the thaw settlement problems.

2 WITNESS CLARK:

3 A I think the context was,  
4 Mr. Commissioner had said that I had stated that  
5 running a pipeline at above freezing temperatures  
6 through the continuous permafrost zone would create  
7 horrendous problems. I was rather surprised by the  
8 word "horrendous", it is not an adjective that I  
9 normally use. I tried to find some reference to it.  
10 I don't think that I ever said that really -- is what  
11 I am getting at.

12 MR. GENEST: But you are  
13 politely saying that you were misquoted.

14 A Certainly the problems  
15 are very different and as Dr. Morgenstern points out  
16 we would have a severe situation with the pipeline  
17 performance in ice-rich soils. The only thing I could  
18 find by going through the volumes which startled me  
19 by their number when I went through our cross-examination  
20 and evidence in chief the last day or so was a question  
21 put to me by Mr. Anthony.





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1 I don't have the exact  
2 reference but it was to the effect had we done any  
3 studies on -- had we been asked to do any studies on  
4 conducting the gas at above freezing temperatures through  
5 the continuous zones and I replied that we hadn't been  
6 asked to study that. Later Mr. Templeton raised the  
7 point and I think that we stated our position there.  
8 It was on March 21st, and according to Mr. Templeton  
9 in his question he says, "okay, on another subject in  
10 the discontinuous permafrost zone, which would cause  
11 the least environmental change, a chilled pipeline  
12 or a non-chilled pipeline?" And my answer was:

13 "That is a question that we would have to  
14 look at almost on a site specific basis.  
15 Our concept has been to bring chilled  
16 gas down to that point in the discontinuous  
17 zone where we can then convert to an  
18 unchilled mode and not have to deal with  
19 major problems downstream, problems of  
20 melting of permafrost. We like the  
21 line where it is now. There is an area  
22 where clearly it is better to be chilled  
23 because the problems associated with  
24 massive ground ice melting and not  
25 encountered with a chilled line. There  
26 are other areas where it is clearly better  
27 not to be chilled because the problems  
28 perhaps would be inhibiting frost heave.  
29 Then there is a gray area where it could  
30 be a little bit one way or the other.



Clark, Morgenstern, Slusarchuk  
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1 We think that we picked the area  
2 that we can support and we think  
3 is the place 'to convert  
4 from chilled to non-chilled."

5 So that is the only reference that I could find  
6 that would pertain to that.

7 THE COMMISSIONER: Well,  
8 forgive me, I certainly won't seek in any way to  
9 hold you to an expression you didn't use, but you  
10 lapsed, I had thought from strict engineering terminology  
11 and I seized on it.

12 MR. MARSHALL: Mr. Commissioner  
13 if I might just comment for Mr. Waddell's benefit.  
14 In attempting to assist Dr. Clark in tracing the  
15 "horrendous" reference, I made use of Mr. Waddell's  
16 index and was unable to find any of these subjects in-  
17 cluded among the topics that are found in the index.  
18 There is no page for "horrendous" or for "frost heave"  
19 or for "thaw settlement".

20 THE COMMISSIONER: Well, I think  
21 two of those are significant omissions.

22 MR. GENEST: Well, sir,  
23 we will develop these as we go along. Perhaps if  
24 I could now turn to Dr. Slusarchuk --

25 THE COMMISSIONER: Just before  
26 you do, could I just ask one question first?

27 MR. GENEST: Of course, sir.

28 THE COMMISSIONER: Dr. Adam  
29 said yesterday afternoon, I don't know whether you  
30 were here, he said, well, he said, this isn't such a





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1 tough problem because you can just shut off the  
2 coolers.

3 Can you say something about  
4 that?

5 WITNESS CLARK:

6 A That is quite obviously  
7 one that has occurred to us as well and we have not  
8 only investigated with the people in Northern Engineering  
9 that do these studies, the line flow studies, the  
10 shutting off of coolers, but the flexibility that they  
11 would have in modifying temperatures, in other words  
12 going from minus 10 to perhaps 30 -- or from 10° to  
13 perhaps 30° and they have advised us that it is not  
14 feasible to do that. It is not -- their mechanical  
15 studies and line flow studies have not given us  
16 very much comfort in that.

17 The other problem of course  
18 of just shutting off the coolers is that the ground  
19 begins to melt and the pipe begins to perhaps float,  
20 so it is not a simple solution either in actually  
21 conducting the gas or in designing for that.

22 But it is certainly one that has been looked at.

23 MR. GENEST:  
24 O Dr. Slusarchuk, I  
25 would to, -- it might be useful, Mr. Commissioner,  
26 if you had volume 69 which is the evidence of Dr.  
27 Williams because I am going to be referring extensively  
28 to it.

29 Can I turn your attention  
30 to, I want to turn your attention to several transcripts  
references. The first is at page 10237, that is all



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1 volume 69, 10237, at line 7 and I would like to  
2 quote from that, line 7 to 16, because I want here  
3 to get at the basic reasons which Dr. Williams postulates  
4 for his theory and have your comments on them. Dr.  
5 Williams says here:

6 "I want to direct your attention to  
7 the processes which are actually  
8 going on in the soil to the nature  
9 of the pulling forces, that is , the  
10 nature of the forces which are trying  
11 to pull or hold the water in the  
12 freezing soil because clearly the  
13 magnitude of a shutoff pressure  
14 necessary to prevent or reverse the  
15 flow of water is determined by the  
16 freezing soil's ability to draw in  
17 water. The maximum pulling force  
18 the soil can exert is ultimately  
19 the shutoff pressure."

20 Then if we go to page 10247, where he is talking of  
21 Dr. Hoekstra's paper and his experiment described in  
22 that paper, 10247, line 10, there appears this  
23 statement:

24 "Now, Hoekstra didn't have an infinitely  
25 long time available for his experiments  
26 either, but he nevertheless managed to  
27 make measurements of very high heaving  
28 pressures. He called them expansive  
29 pressures, heaving pressures. He didn't  
30 use the word 'shutoff pressure' of course,  
31 but these high heaving...."





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I think it should say "or",

"...expansive pressures are of course the shutoff pressure."

And then if we go to page 10299, which is a statement that occurs during Mr. Marshall's cross-examination, at line 14, Dr. Williams says this, the question is:

"Well, I understand, sir, that the heaving rate in Hoekstra's experiment was zero and he was dealing simply with a 'redistribution of moisture within the soil sample."

Answer :

"Yes, well,,you see he was getting maximum pressure and of course the maximum pressure is that at which the heaving just ceases, but in his experiment there was expansions going on, but the way it was done was to measure the pressure developed. Now, the maximum pressure here is the shutoff pressure."

Question:

"There was no expansion and there was no heave?"

Answer :

"Well, one would hope not, that is the definition of the maximum pressure."

And my last reference appears at page 10352.



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THE COMMISSIONER: 10352?

MR. GENEST: 10352, sir, at

line 14, and it is an answer to a question by the  
Commissioner who has just summed up the concerns.

The Commissioner says:

"Subject to that have I in a very  
rough way summarized your concerns about  
the approach Arctic Gas has taken?"

Answer:

"Yes, I think so, except you did stress  
the fact that they, according to my  
viewpoint, have failed to measure the  
volume of heave at the dial gauge  
and Mr. Marshall raised that question.  
I wasn't very concerned about the fact  
because they didn't in their report  
really make any great claims that they  
had measured to the required accuracy."

And what I particularly call your attention to is the  
following sentence:

"The report is based on stopping the  
flow of water into the bottom of the  
soil, but I am saying that that is  
not really enough just to stop the  
water flowing into the soil."

Now, with these transcripts as background, Dr.  
Slusarchuk, is it correct to say that what Professor  
William's contends, is that the shutoff pressure will  
ultimately be the maximum pulling force that the  
frozen soil can exert?



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1 WITNESS SLUSARCHUK:

2 A Yes, sir.

3 Q And that this shutoff  
4 pressure or maximum pulling force is equal to the  
5 same thing as the maximum heaving pressure observed  
6 in soils subjected to freezing under conditions  
7 of no volume change?

8 A Yes, sir, that is my  
9 understanding.

10 Q And in fact, conditions  
11 such as that measured by Dr. Hoekstra in the  
12 terms described in his paper.

13 A Yes, sir.

14 THE COMMISSIONER: I wonder  
15 would you mind just repeating that series of propo-  
16 sitions if you don't mind.

17 MR. GENEST: No not at all,  
18 sir. First, that the shutoff pressure will ultimately  
19 be the maximum pulling force that the frozen soil  
20 can exert.

21 THE COMMISSIONER: Yes.

22 Q In other words he  
23 equates the shutoff pressure with the heaving pressure --

24 THE COMMISSIONER: Williams  
25 does.

26 MR. GENEST: -- the pulling  
27 force.

28 THE COMMISSIONER: Williams  
29 does.

30 MR. GENEST: Williams does, that





1 is right, and to put it another way, the shutoff  
2 pressure, maximum pulling force is equal to the  
3 maximum heaving pressure obtained in soils subjected  
4 to freezing under conditions of no volume change.  
5 Dr. Hoekstra's paper described, as he can tell re,  
6 a closed system. There was no room for expansion  
7 of the frozen soil, am I correct?



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WITNESS HOEKSTRA: There's no

room for expansion of the whole soil system. Where the system  
is not closed and . . . water is allowed to flow out of the --

Q Flow out of it.

A -- sample --

Q But is there any room for  
the soil to expand at all?

A There is no room for the  
soil to expand, that's correct.

Q Now does this flatly  
contradict the definition of shutoff pressure put for-  
ward by N.E.S.?

WITNESS SLUSARCHUK:

A Yes sir, it does.

Q What do you equate that  
shutoff pressure to be?

A Well, I  
have three view graphs that I would like to show in  
order to illustrate the fundamental difference here  
between our position and our shutoff pressure, and  
that proposed by Dr. Williams. I think I need to  
go through that exercise in order to get to the  
fundamental difference between our positions.

Q Would you do that, Dr.  
Slusarchuk?

A I see that I have drawn  
my view graph just a little bit too large to be foc-  
used and projected in total,

On this graph along here I have the rate  
of water flow into the freezing soil, in other words  
the soil that is <sup>drawn</sup> into the freezing front where the adjacent





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unfrozen water going into the frozen soil, freezing in the form of lensing and causes heave. Down here I've plotted the rate of water flow out of the freezing soil into another freezing soil, and that is termed expulsion, and that is water at certain pressures upon freezing will push away in front of the soil..

Now right here is the zero point where water is neither entering nor being expelled to the freezing front.

Along here I have plotted pressure increasing in that direction.

Frost-heaving soil and plots the rate of water flow into the freezing soil or out of the freezing soil, and the function of the pressure one will get a line something like that. At the lower pressures you get water being drawn into<sup>a</sup> freezing soil forming ice lenses; as the pressure increases the amount of water you draw in or the rate of water that you're being drawn in is reduced, until you come to a point where you have sufficient pressure to stop the water from flowing into the freezing front. It is at that point that we define our shutoff pressure.

O.K., that's no water entering the freezing soil from the unfrozen soil. If we continue down this line by increasing the pressure, we can measure a maximum heaving pressure from constant volume or in quotes "no heave tests" similar to the



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tests that were conducted by Dr. Hoekstra and cited by Dr. Williams. Now it is these pressures out here that Dr. Williams refers to as the high pulling force, the heaving pressures, and in fact Dr. Williams -- these pressures are in fact Dr. Williams' shutoff pressure.

Now if one is to accept these high shutoff pressures, one must also be -- must also realize that he is getting these pressures at a no heave or a constant volume situation. To us that means that Dr. Williams is applying a shutoff pressure criteria that means that our pipe cannot move. He is -- by his criteria, by his shutoff pressure, he is forcing us to adopt the criteria of no heave of the pipe whatsoever.

Now we know from our analysis that the pipe can in fact can stand differential movement, can stand heave. That is why we are working and designing in this area along here, and to be clear we are designing to control the heave of the water that is being drawn from the unfrozen soil into the frozen soil -- into the frozen soil forming this ice lenses, causing heave. Our job -- yes sir?

THE COMMISSIONER: Would you repeat what you said? You said you're trying to cope <sup>created</sup> with the heave by water being drawn from the unfrozen soil into frozen?

A That's the part that we are trying to control. We are also coping with the natural in situ expansion, we're coping with both, but the pressures associated --

Q That is the unfrozen water



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1 within the frozen soil?

A The unfrozen water within the frozen soil, or the water that was in/situ to start with, and the frost front simply captured it and froze it right in the soil particles and those -- within the soil particles and that water expanded.

Q Yes. In/situ it didn't have to move.

A It didn't have to move, it's already there, so we're coping with that, we're not trying to control that. We're just trying to control the part of the heave due to water being drawn into the freezing front <sup>the</sup> from/surrounding unfrozen ground, and that is in that area.

Now what I'd like to do is just take a moment and describe the frost heave test or the tests that correspond to a no-volume or a no-heave or a constant volume test from which Dr. Williams has obtained his large shutoff pressures, and compare those with the tests that we are running, which we run at constant loads. We can run a test at different loads in order to get points along that line, in order to establish that line, in that area of our interest for the different soils along our route.

Then I'd like to show you, sir, why I think that our tests are applicable to our pipeline case. These are not -- and this is in addition to the fact that I already have said that these force us into the criteria of absolutely no heave of the pipe, so that in itself is a bad point from our point





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of view with regard to Dr. Williams' shutoff pressure.

Q Excuse me. I don't understand why you say that he proceeded on the basis that you could not allow any heave of the pipe. I thought he was acknowledging there might be a certain amount of heave of the pipe, but that the extent of the heave that was likely to occur had been under-estimated. I'm missing something here. Maybe you could try again.

A Well, this is what he said. As you say, he did allude to heave. Now I'm not sure how Dr. Williams makes the logic step between the no-heave test and the high pulling forces to the assertion that he can allow us to have some heave. Maybe that's a question you can put to him, because I can't follow that logic step.

MR. GENEST: Why not?

A Well, I can't follow it because the evidence that was just read in here with regard to his definition of shutoff pressures and maximum pressures and pulling forces and experiments that he refers to, and uses as evidence of his large pulling forces, and uses those numbers, they're all with regard to the no-heave or the constant volume situation.

MR. GENEST: Q What's the difference between the two? Why are they large and a constant volume? As I understand, a constant volume there is no room for movement. Am I right?

A That is right, and I was going to explain each one of those tests and show those features in my next view graph. I could



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1 either go and do that now, or maybe we'd like to pursue  
2 this.

3 THE COMMISSIONER: No, well  
4 you go at your own speed here.

5 A I'd first like to deal  
6 with the numbers that were obtained way down on my  
7 graph at the high pressures that Dr. Williams was  
8 talking about, and how they were obtained from the  
9 constant volume tests, such as Dr. Hoekstra undertook,  
10 and Dr. Williams was citing. In fact, I'm simply just  
11 explaining to you again Dr. Hoekstra's test, in fact.

12 You have a soil sample in here  
13 within a very stiff container, and a very stiff frame  
14 by which you can measure the pressure. You start at the  
15 bottom. At the bottom of the sample you have a porous  
16 plate so that as you start to freeze the sample, the  
17 in situ water is going to expand, the volume of the  
18 container is not going to expand so you force the water  
19 to come out. It's the only thing that can happen unless  
20 you burst the container.

21 The stiff frame measures the  
22 load that the heaving pressures are exerting against  
23 that, and if we look up here, here we have a plot of  
24 load increasing this way, versus time. The load increa-  
25 ses very quickly and then, to very high values, and then  
26 very slowly continues to increase, much in the manner  
27 of what Dr. Williams is talking about, about the loads  
28 increasing with time; and these are results that you  
29 could look at by looking at Dr. Hoekstra's paper.

The point that I'd also like



to make is that if you look at this graph here, where I have "heave" plotted, and this is zero heave, versus time, you will plot no line at all. It would follow right on that zero axis there. There is zero heave. There is no heave whatsoever, and that is the number that Dr. Williams was using in this kind of a test when he had no heave to get this large -- the kind of test to get his large numbers, and that's why I say my interpretation of that means that he is also forcing our pipeline to have no heave if he wants us to live with these large heaving pressures. He wants to tell us that these are the right pressures. He's also got to be telling us our pipe can't move.

MR. GOUDGE: Sir, I wonder if Mr. Slusarchuk might first number his overviews, and secondly when he points to each one of the parts of the overview, might indicate whether it's top, middle or bottom. We're going to be asking to get copies of these and send them with the transcript to Dr. Williams. He's not here to see the slides and I would like to have some way of matching what you're saying, Dr. Slusarchuk, to the slides you're pointing at.

A Yes, I'll do that.

THE COMMISSIONER: Well, this one we're looking at now is the second one.

MR. GENEST: Yes, slide 2.

Q Before you leave that one, and if I'm getting ahead of myself, you tell me, if you gained a little room for that soil to move or heave, what would happen to the high pressures measured?





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1 A Well, the high pressures  
2 would immediately drop off. If you had some kind of  
3 a screw jack on here that you could just allow that to  
4 move, say a few thou an inch, this load would immediately  
5 just slip right back down to zero and then it would of  
6 course -- and then you'd just start your test all over  
7 again if you didn't keep adjusting; but if you allow this  
8 to move a little bit, then these pressures are relieved.

9 Q Well, do I understand then  
10 that a slight heave in the soil will immediately make  
11 a dramatic difference in the pressures?

12 A Yes, that's correct.

13 For Mr. Goudge, this is the  
14 left side only of graph No. 2, and I want to now talk  
15 about the right side of graph No. 2.

16 MR. GOUDGE: Thank you, sir.

17 A I now want to talk about  
18 a constant load test instead of a constant volume  
19 test, and these are the tests that we have carried  
20 out, and the tests that we feel are representative  
21 of what is happening in the field.

22 Here is our soil sample that  
23 we are going to freeze, and on top of the soil sample  
24 we have a moveable loaded piston or a constant surcharge  
25 pressure. We put a constant load on this piston, it is  
26 free to move up and down as it feels, as it likes to  
27 in response to what the frost-heaving characteristics  
28 of the soils are; if the pressure is what we call the  
29 shutoff pressure, and it is -- the bottom of the  
30 sample here is attached to a water source, if the pressure



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is low, then water will be drawn into the freezing soil, and this will heave at a rate commensurate with the heaving characteristics of that soil.

Now, if you look at the load versus time, we would have --

MR. GENEST: Q You're indicating the middle chart on the right-hand side of chart 2.

A I have load here and time here. We would run one test at load 1, another test at load 2, another one at load 3, and another one say at a shutoff pressure. O.K., now if we were measuring the heave, the lensing heave, and by the lensing heave I mean the amount of heave due to the water that's drawing into the sample upon freezing we would measure something like this with time, lensing heave, this is the top graph now, lensing heave increasing that way and time that way; with a low pressure we'd have our heave occurring at a fairly fast rate, at the next load at a slower rate, at a slower rate for load No. 3. And finally at the shutoff pressure we would be measuring a lensing heave that was right along that zero axis, in other words there would be no water moving in or out of the sample. We'd be measuring this water and we'd notice no change.

If we applied a test at another load we would have in fact been expelling water and measuring additional water in our water sample here, in our water supply.

Now, why is our constant load test more representative, or why is it representative



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of our heaving -- of our buried pipeline, our chilled  
buried pipeline in unfrozen ground situation? O.K.,  
what I am saying -- well, first let me describe what  
I have here. This is the ground --

THE COMMISSIONER: You're now  
on the third graph. Go ahead.

A We now have the ground  
surface here. This is the pipe here. This is the  
position of the freezing front. I just put in a few  
token ice lenses in behind the frost front. I'm putting  
some ice lenses --

MR. GENEST: Q When you say  
"token", you say there's a lot of ice lenses inside.

A There's ice lenses in  
there, I just didn't want to confuse the diagram.

I'm now talking about the ice  
lenses at the freezing front, the ones that are forming  
here and they're forming here because they're drawing  
water in from the adjacent unfrozen ground, and freezing  
and forcing the pipe up. There is -- when these ice  
lenses attempt to develop here, they have a certain load  
to lift up. They've got all of that frozen soil, if we  
put a berm on they've got to lift the berm; if we wanted  
to -- there are other things we could look at too. This  
is moving up through the soil, then the frozen soil is  
then having to sheer, have a sheer plain through there  
so that you've got further resistance through there, and  
you can take that into account if you like. But there  
are a number of forces trying to keep that pipe down,  
mainly the weight, and a lens trying to heave it up.





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So that is very similar to our constant load test. We put a constant load on our sample in our laboratory and it heaves away, as it would like to, for that particular soil, at that pressure. We run it at different pressures, so that as our frost bulb grows and gets at different pressures, we then have an idea of the rate at which ice lenses want to grow in that soil at that overburden pressure. If we run through an analysis and find we're getting too much heave, for example, we can bury our pipe deeper to get additional surcharge pressure like that, to transfer this whole freezing zone down there. If that's not enough, we put a surcharge berm on top in order to give us again more load for which these ice lenses have to work against. The end result being that the pipe heaves upward at the rate determined by the load on the frost front.

That sort of ends my discussion.

Q Let me pursue it.

THE COMMISSIONER: The graphs should be marked.

MR. GENEST: I'll have them xeroxed, sir.

THE COMMISSIONER: Fine.

MR. GENEST: Well, I'll give the originals to Miss Hutchinson. I wonder -- well, perhaps we can remember the last graph.

Q Dr. Slusarchuk, as I understand Dr. Williams' thesis is that you do not solve your problem by applying a berm that is sufficient to stop the water coming to the edge of the frost front.



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1 that you illustrated on your last graph, that there is  
2 present inside the frozen soil, pulling forces that will  
3 attract water, that will make water migrate in, notwith-  
4 standing that you have enough shutoff pressure to stop  
5 the water coming and migrating to the edge of the  
6 frost front. Now is that what he said?

THE COMMISSIONER: Excuse me.

8 I'm awfully sorry, would you repeat that? I --

9 MR. GENEST: No, it's not one  
10 of my written questions, Mr. --

11 Q My understanding is that  
12 Dr. Williams' thesis is that he says that the existence  
13 of pulling forces inside the frost front that's caused  
14 by reason of water at lower temperatures than the 32-  
15 degree isotherm exert a very strong pulling force, and  
16 that notwithstanding that you are successful in stopping  
17 ice lensing at the edge of the frost front, water will  
18 migrate inside and cause heave in that way.

19 THE COMMISSIONER: I follow  
20 you but --  
21  
22  
23  
24  
25  
26  
27  
28  
29



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1 MR. GENEST: Q What I am trying to get  
2 at is the, as I understand it, you define shutoff  
3 pressure as the shutoff pressure required to stop  
4 the water in forming at the frost front.

5 A Yes, that is correct.

6 Q Dr. Williams defines the  
7 shutoff pressure as equal to the pulling forces in  
8 a no heave situation.

9 A That is correct. Yes,  
10 that is correct.

11 Q And what do you say about  
12 that? What is your position as to whether the suction  
13 at the freezing front is the one that has to be  
14 overcome and that once that is overcome no water  
15 can come in.

16 A Well, if you define the  
17 -- well, to me it is very clear. If we can stop the  
18 water coming into the freezing front, as we have done  
19 then there is no water moving in beyond, behind the  
20 freezing front <sup>or through the freezing front</sup> / from water outside the ground. There  
21 may be some redistribution of water in behind the  
22 freezing front with the water that is already there or  
23 initially was in situ, but -- and this is  
24 related to the unfrozen water content that is back in  
25 there, of course.

26 Q Well, do I understand  
27 that that migration then cannot occur if there is a  
28 slight amount of heave that's allowed?

29 A No, I don't think that  
30 that is correct. You are talking now, you are asking





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1 about the migration of the water and the frozen  
2 soil and back --

3 Q I am talking about  
4 migration of water from outside the frozen soil into  
5 the frozen soil.

6 A Well, if you apply our  
7 shutoff pressures, then our position, or my position  
8 or my belief is that you can't get water from the  
9 unfrozen soil into the frozen soil.

10 THE COMMISSIONER: Well,  
11 can I take a crack at this. I thought I understood  
12 what Mr. Genest was driving at.

13 Williams said that there is  
14 unfrozen water in situ, or whatever the expression  
15 is, that is within the frost bulb, assuming theoretically  
16 that you are working with a frost bulb and you say ,  
17 well, if we make sure that there is no migration of  
18 water into the frost bulb, if our shutoff pressure is  
19 sufficient to insure that that doesn't occur, we are  
20 okay.

21 A Right.

22 Q Williams says you have  
23 overlooked the fact that there is within the frost  
24 bulb a quantity of water that is unfrozen even  
25 though there are temperatures below freezing, he said  
26 that is a phenomenon that we are all familiar with --

27 A Yes --

28 Q -- even though he didn't  
29 -- he said that there was no point in explaining it,  
30 no doubt thinking I wouldn't understand anyway, but in



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1 any event, he seemed to be saying that you had overlooked  
2 that and Mr. Genest is asking you now, as I understand  
3 him, if you shut off the ice lensing at the frost  
4 front, what about the unfrozen water within the  
5 bulb, is it going to freeze, doesn't that create the  
6 magnification of the volume and the heaving and so  
7 forth and aren't you in trouble ?

8 A Well, the water behind  
9 the frost front will freeze and it can freeze if the  
10 temperatures get lower and we account for all of that  
11 heave by assuming that all that water expands, even  
12 the unfrozen water content. We know there is un-  
13 frozen water content in there, but from a conservative  
14 point of view we don 't account for it. We know that  
15 means that we over predict the amount of heave from  
16 that point of view, but in fact we account for it  
17 by allowing all of it to expand.

18 Q Well, would that be a  
19 point where Williams, if this is so, has misunderstood  
20 the basis on which you have made your calculations?

21 A I am not sure that there  
22 is that misunderstanding, sir, because in the transcript,  
23 between ourselves and Dr. Williams about how we  
24 treat the in situ water expanding versus the lensing  
25 water, we seem to go round and round and that over  
26 ten or fifteen pages of transcripts and we end up, you  
27 may recall him asking me to explain it, or you asking  
28 me to explain it and I did and then Dr. Williams asked,  
29 "Well, how much heave are you going to get?", and I  
30 said, "We are going to get a foot," and he says, "Exactly,"



1 that that is what he would get too. We don't seem to  
2 be in any disagreement there.

3 THE COMMISSIONER: All right.

4 MR. GENEST:

5 Q Well, there's -- let me  
6 get at it this way. There is heave associated with  
7 in situ water, first of all when it freezes, when you  
8 are putting the pipeline in and it is warm soil and  
9 there is water in it that soil will freeze and will  
10 produce a certain amount of heave.

11 A Yes, sir.

12 Q That you account for in  
13 your predictions.

14 A That is correct.

15 Q Then after that process  
16 has occurred there is still present within the  
17 frozen soils some pockets of unfrozen water.

18 A There is unfrozen water  
19 films around the soil particles and around the ice.

20 Q Right, and there is also  
21 ice at different temperatures.

22 A Yes, sir.

23 Q Am I correct in under-  
24 standing that there is migration along temperature  
25 gradients, that warm ice will flow towards, over  
26 time, towards cold ice?

27 A Yes, sir, the ice at  
28 the warm side will melt into the water film, transport  
29 by the water film and redeposit as ice at a lower  
30 temperature.





Clark, Morgenstern, <sup>10855</sup>Slusarchuk  
Harlan, Hoekstra  
In Chief

1 Q And would that produce  
2 some heave within the system?

3 A It can produce a small  
4 amount of additional heave if for example the  
5 location where the ice was at a lower temperature and  
6 that migrated to a colder place and formed as a lens  
7 or any other ice deposit and a void was left where that  
8 ice once was. Now, from that point of view you  
9 could get some small additional heave in behind the  
10 frost front. They are governed by the rates of  
11 the water migration in the frozen soil.

12 Q But you say that you  
13 have accounted for that by assuming that every bit  
14 of water freezes.

15 A We have accounted,  
16 we have accounted for every bit of the water freezing  
17 in situ, we have not actually accounted for that small  
18 little bit of redistribution that might take place  
19 and where a void in the actual frozen soil is left.

20 Q What is the amount of  
21 that heave? Is it significant in engineering terms?

22 A Our view is that it is  
23 not.

24 Q Well, to sum up then,  
25 do I take it that your fundamental disagreement with  
26 Dr. Williams as to the definition of the proper  
27 shutoff pressure, is that Williams derives his figures  
28 from a situation where no heave whatever is allowed.

29 A Yes, sir.

30 Q Whereas your pipe allows



Clark, Morgenstern, Slusarchuk  
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In Chief

1 for heave.

2 A That is right, sir.

3 Q And that the heave of  
4 pipe immediately and dramatically reduces the high  
5 pressures?

6 A The potential for those  
7 high pressures, yes, sir.

8 Q The potential for  
9 the high pressures.

10 I am changing subjects, sir,  
11 is it convenient for coffee?

12 THE COMMISSIONER: We will  
13 adjourn for coffee.

14 (PROCEEDINGS ADJOURNED)  
15  
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Clark, Morgenstern, Slusarchuk,  
Harlan, Hoekstra

(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

MR. GIBBS: Just before Mr. Genest changes the subject, not intending to cross-examine, I wonder if I might ask Dr. Slusarchuk one or two questions about one of his slides?

CROSS-EXAMINATION BY MR. GIBBS:

Q Dr. Slusarchuk, I have in mind the diagram which shows the piston with the weight on it.

A Yes sir.

Q That's based on an assumption, is it, that there is an infinite amount of water that can be drawn in?

A Yes, that's correct. In our test we have an infinite supply of water available, and we view that as a worst case or a very conservative position with regard to the test results.

Q You took the most pessimistic view you could in making those tests?

A Pessimistic or conservative yes.

Q Yes, and that that's not likely to be the case throughout the whole length of the 800 miles of pipeline?

A No sir, it won't be for the whole route.

MR. GIBBS: Thank you, sir.

DIRECT EXAMINATION BY MR. GENEST (CONTINUED):

Q I'd like to move now to





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In Chief

1 Dr. Hoekstra and on the subject of pulling forces that  
2 were described by Dr. Williams, and perhaps, Dr. Hoekstra,  
3 I could refer you and the Commissioner and my friends to  
4 the transcript of Dr. Williams' examination at page  
5 10241 where I think we find a statement of his position,  
6 at line 6, and perhaps I could read it, it's page  
7 10241, line 6 and I quote:

8 "Now, up until fairly recently these pulling  
9 forces, as I said, were believed to be effective  
10 at the frost line, the boundary between the fro-  
11 zen and unfrozen soils. That is where the  
12 temperature, 32 degrees Fahrenheit. But if the  
13 water occurs well into the frozen soil, as I  
14 have shown, we are faced with a question of  
15 whether at the lower temperatures 30 degrees  
16 Fahrenheit, 28, or whatever, within the frozen  
17 layer, perhaps the water there is subjected to  
18 much greater pulling forces. Indeed it seems  
19 to be quite definitely established that this  
20 is the case.

21 And in another diagram, the next one, please," and that  
22 sir, was diagram part 6 which we will be dealing with,

23 "I show a piece of frozen soil and on the  
24 left-hand side of the piece of frozen soil  
25 I have listed some temperatures which would  
26 quite well exist in that piece of frozen soil,  
27 it's a temperature gradient therefore, and on  
28 the right-hand side I simply put the magnitude  
29 of the pulling forces which are associated with  
30 the water at the temperature corresponding.

Stark, Mordechai, Sinschuk,  
Harlan, Hekstra  
In Chief

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water occurs well into the frozen soil, as  
have shown, we are faced with a question  
whether at the lower temperatures 30 de-  
Fahrenheit, 28, or whatever, within a  
layer, perhaps the water is frozen, and  
much greater force is required to pull it  
to be quite definitely established that

and pl

and pl

I think a piece of wood, 1 and 2

left-hand side of the piece of frozen

I have listed some temperatures which would

quite well exist in that place. I think

it's a temperature gradient that would

the right-hand side I simply put the number

the pulling forces which would

the water at the temperature corresponding.

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Now the pulling forces are the forces that we're going to have to overcome by applying shutoff pressure if we are to completely stop the frost heave."

Now I'd like you to comment on that, Dr. Hoekstra.

WITNESS HOEKSTRA: In his direct evidence Dr. Williams has two arguments for the existence of pulling forces that are considerably higher than the one that Dr. Slusarchuk has measured in his test-site. One of those arguments is experimental, and Dr. Slusarchuk has dealt with that. He said those pressures originate from measurement of constant volume tests and do not apply to tests that are run under constant load, which is the pipe, because the pipe could be allowed to heave. So in this argument --

Q Could I interrupt you there? Your test that was referred to by Dr. Williams was a constant volume test.

A It was a constant volume test, and it originated at very high pressures, but those are not the pressures that one would find in systems like a pipeline in which you allow some heave.

Here on page 10241 we have a theoretical argument for the existence of very high pulling forces, and this is where I like to address myself to. position is that the theoretical argument is not correct, and I'd like to use some illustrations to make my point.

This is diagram 6 that was used



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by Dr. Williams, and what we have here, the way I understand it, is we have here a piece of frozen ground, and frozen ground is full of ice lenses. There is a temperature gradient in the frozen ground, at the top it's cold, it's 28 degrees Fahrenheit. The temperature increases to the bottom but it's still below freezing. The temperature at the bottom is 31.9 degrees Fahrenheit, and here it says:

"Recent findings."

Now, corresponding to each temperature gradient is listed a pulling force, so at a very cold temperature there is a pulling force of 54,000 pounds per square foot, that is it is about 20 to 15 times higher than the pulling forces measured by Dr. Slusarchuk. Here at the bottom there is a pulling force of 1,350 pounds per square foot, so when the temperature increases, the pulling forces decreases.

Now although not directly mentioned in his direct evidence, the equation from which these numbers are derived is a very classical equation in thermodynamics. It's a very old equation, too, it's not recent, and if we just go through the parameters that make up this particular equation, we see --

MR. GENEST: I'm sorry, Dr. Hoekstra. Just so the record will be clear, you have now put up a chart showing a thermodynamic equation.

A And it's chart No. 1.

Q And it's chart No. 1.

Sir, I wonder if it wouldn't be useful to ask the reporters to copy that into the transcript at this





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stage rather than have it as an exhibit?

THE COMMISSIONER: All right,  
we'll pause a moment and you can do that.

(CHART 1:  $S = \frac{RT}{VW} \ln \frac{P_{ice}}{P_{water}}$ )

S= Suction; R= Gas constant; T= Temperature;

V= Volume of 18 gr. of water

Pice = vapor pressure of ice

Pwater = vapor pressure of water)

MR. GENEST : All right.

A So that just goes through  
the --

THE COMMISSIONER: This formula  
is the constant phenomenon of water being drawn to the  
frost front, is that right?

A No.

Q Remaining unfrozen in  
frozen soil?

A No sir. This formula, if  
you use these temperatures in that formula you arrive  
at those particular pressures, so I'll deal with those  
questions.

MR. GENEST: Q You're saying  
that's how -- that's the formula used by Dr. Williams  
in arriving at those figures on his chart 6?

A That is correct.

Q The pulling force figures.

A Right.

THE COMMISSIONER: The pressure  
increases as the temperature decreases.



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1 A That's correct.

2 Q This formula accounts for  
3 that.

4 A This formula was  
5 used in arriving at those particular pressures.

6 Q All right.

7 A And Dr. Williams claims  
8 that those are the pulling forces that the frozen ground  
9 exerts on <sup>the</sup> water in the unfrozen ground. He states that  
10 those are the pulling forces you will have to overcome  
11 in order to stop the water flow from unfrozen to frozen  
12 ground.

13 Q O.K.

14 A So I would just like to  
15 go through the parameters of this equation, so we have  
16 the suction or the pulling force, and "R" is constant,  
17 "T" is the temperature, 28 degrees that will be, 31  
18 will be another temperature, we have the volume of  
19 18 gram of water, that's this VW, and then we have  
20 the vapor pressure of ice and the vapor pressure of  
21 water. Those are the parameters that go into the  
22 particular equation.

23 MR. GENEST: Q What does "ln"  
24 stand for?

25 A "ln" is the logarithm the  
26 natural water logarithm.

27 Now at the zero degree isotherm  
28 that's 32 degree Fahrenheit, the vapor pressure of  
29 ice and the vapor pressure of water are both equal,  
30 so the suction force goes to zero. I'll go back again



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1 to diagram 6 that was used by Dr. Williams. Now this  
2 equation can be applied wherever water and ice co-  
3 exist, where they're both present. There is unfrozen  
4 water in the frozen ground; there is ice there, so I  
5 can apply the equation at this point where I get  
6 54,000 pounds per square foot. I can apply it at this  
7 point which I get 1,350 pounds per square foot. So as  
8 long as ice and water co-exist, this equation, I have  
9 a lot of limitations myself, but that's how we use it.

10 Q Dr. Hoekstra, I'm sorry,  
11 can I interrupt you? That formula that you showed  
12 expresses a law of thermodynamics, does it?

13 A It's a very old classical  
14 equation in thermodynamics, when two phases, water and  
15 ice, co-exist.

16 Q And does it express the  
17 tendency of temperatures -- of substances at different  
18 temperatures to try and equalize? Or am I wrong there?

19 A Well, I'll come to that.

20 Q Perhaps you could come  
21 to that later.

22 A Yes. O.K., so now I  
23 think I'd like to come to the point of how I think Dr.  
24 Williams used that equation. This is this chart No. 2.  
25 So here at the bottom--

26 THE COMMISSIONER: This is  
27 Williams chart 2?

28 A No, this is my chart,  
29 and this is, I think, how he used it. Here we have this  
30





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1 frozen ground, there is the freezing front, and over  
2 there we have the unfrozen ground, and so we have ice  
3 lenses in the frozen ground. Here the temperature is  
4 low close to the freezing front, the temperature is  
5 very close to 32 degrees Fahrenheit, or zero degrees  
6 Centigrade.

7  
8 O.K., so if we use that  
9 equation at this point where it's cold, we get those  
10 very high pulling forces, 54,000 pounds per square foot.  
11 We can apply the same equation right at the freezing  
12 front, because also there ice and a little bit of  
13 frozen water co-exist, so there we would get a very  
14 small value. How small? Thermodynamics cannot  
15 tell you because we don't know what the temperature  
16 right at the point is, where ice first forms. So if  
17 we have no load on the frozen ground, this small pulling  
18 force, this intercept will be this suction by the  
19 frozen ground on the water into the unfrozen ground.

20 Now the question is what  
21 load do I have to apply in order to stop this flow right  
22 at that point? I want to only stop the water from the  
23 unfrozen ground going into the frozen ground. It seems  
24 to me quite evident that the only load that I have to  
25 apply is to -- is the load necessary to put this curve  
26 through the intercept. In no way do I have to apply  
27 this enormous load because this equation not only applies  
28 here where I get this large load, also right at the  
29 freezing front, so that the load I have to apply to  
30 make this curve go to zero is right here at the freezing  
front, It is that pressure.



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THE COMMISSIONER:

Q Let me see if I understand you at this point. You say that the shutoff pressure that you have to apply need only be sufficient to cope with the pressure that is exerted by the freezing front on the unfrozen water and that where you have the lower temperatures deep within the frost bulb it is not necessary to have a shutoff pressure that would cope with that pressure, is that the point?

A That is correct, because this I think is quite a difficult point to understand, but it is just that what determines suction if you have frozen ground where ice is present is only the temperature. There is no way in which this suction force is transmitted to that point, because the equation applies wherever ice and unfrozen water co-exist together. Temperature determines the suction.

Q So that force or tendency exists within -- deep within the frost bulb, but it isn't exerted on any unfrozen water?

A That is correct.

Q Because the unfrozen water lies beyond the frost --

A The unfrozen water co-exists throughout the frozen ground. We only have to deal with it at that point.

Q Yes.

A Now --

MR. GENESE: Excuse me, if I could just hook on to, Mr. Commissioner, he said that



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1 the pulling forces inside the freezing soil do not  
2 affect unfrozen water and my understanding was that  
3 it affected unfrozen water or other ice within the  
4 frozen soil --

5 THE COMMISSIONER: Well, that  
6 is what I was coming to.

7 A Yes, right.

8 MR. GENEST: What we are  
9 talking about is the attraction of water from outside.

10 A What those suctions are  
11 doing is they will cause redistribution of ice  
12 within the frozen ground, in other words, this ice  
13 lens may very slowly with time move and land up  
14 here, so we are redistributing ice.

15 THE COMMISSIONER: But you  
16 are not --

17 A But I am not pulling in  
18 unfrozen water from the unfrozen ground.

19 O Right, but Dr. Slusar -  
20 chuk dealt with this a minute ago, but are you saying  
21 you are not converting unfrozen water within  
22 the frost bulb to ice or that the amount that you are  
23 converting is insignificant as Dr. Slusarchuk said?

24 A So unfrozen water in  
25 unfrozen ground only depends on temperature, so that  
26 the only instant when I change unfrozen water to ice is  
27 when, at this particular point, I lower the temperature  
28 at that point, so when the frost bulb moves further into  
29 the ground and the temperature at a particular point  
30 gets higher, then some of that unfrozen water will form





1 ice.

2 Q The temperature gets  
3 lower.

4 A Lower, right, but some  
5 of that unfrozen water freezes and becomes ice.

6 Q Yes.

7 A Now, to give you an  
8 idea of the magnitude, if we take, deal with a  
9 silt soil, you know, soils that will be common along  
10 the route, the unfrozen water content at  $-2^{\circ}$  will  
11 be .0 gram per cubic centimeter, and that will expand  
12 to .032 gram per cubic centimeter, so it is an extremely  
13 small amount.

14 Q And that is the water  
15 that Dr. Slusarchuk said is film around certain  
16 particles of soil, around the ice lenses --

17 A That is correct.

18 Q -- within the frost  
19 bulb.

20 A Right.

21 Q And it is insignificant,  
22 he says, from the point of view of frost heave.

23 A From the point of view  
24 of frost heave, from a lot of other points it is a  
25 very important thing.

26 So, now, I have used this  
27 equation. I do it with a lot of limitations. I  
28 would like to point that out too. Here again I put  
29 on the chart number one which shows the equation, because  
30 if we go again and look at the parameters in this



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1 equation you see there is no soil parameter in this  
2 equation at all. There is temperature, there is vapor  
3 pressure of ice there is vapor pressure of water.  
4 Nowhere do I see a soil parameter in this system, so  
5 this equation also tells me that for each soil  
6 type would exert the same pulling force that gravels,  
7 as well as clays, would have enormous pulling forces  
8 on the water in the unfrozen ground. So I think to  
9 some extent this whole controversy can be settled  
10 very simply by providing a barrel of gravel and a  
11 pail of water and producing heave in that system. It  
12 just won't work because we know by observation that  
13 some soils heave and others do not. Thermodynamics  
14 cannot account for that particular situation.

15 Okay, so now we have come to  
16 the point, I think that from thermodynamics  
17 we cannot calculate the suction forces exerted by the  
18 frozen ground on the water in the unfrozen ground.  
19 Now, frost heaving has been studied for decades by  
20 many scientists in many different countries and I  
21 would like just to -- and one of the scientists that  
22 has studied extensively frost heaving is Dr. Ducker  
23 who is Swiss and he wrote a textbook on frost heaving  
24 called "Der Frost Im Bargund" and it is published  
25 by Springer Verlag in Vienna.

26 MR. GENEST: I think we had  
27 better spell that, Dr. Hoekstra.

28 A It is not translated, it  
29 is called "Freezing in Construction Soils."

30 THE COMMISSIONER: Excuse me,



1 Mr. Templeton and Dr. Adam, if you and your colleague  
2 want to take a seat closer to the front where you can  
3 see this thing, you are certainly welcome to do so.

4 MR. GENEST: We will get  
5 copies made and distributed over lunch hour.

6 A So this chart is directly  
7 taken from that particular textbook and in this  
8 graph Dr. Ducker summarizes twenty decades of  
9 research in Scandinavia, in Germany, in Switzerland  
10 and in Holland and what he plots here is permiability  
11 of water in <sup>the</sup> unfrozen soil, the saturated soils and  
12 the permiabilities. So clay soils would be over here,  
13 silt soils in this area and there would be sand  
14 soils, and here he plots the pulling forces exerted  
15 by the frozen ground on water in the unfrozen ground  
16 and all this data that are on this graph are the  
17 summary of many scientists.

18 Q You said twenty  
19 decades, did you mean two? Twenty years or 200  
20 years?

21 A Well, you know, we could  
22 start -- whether we start in 1850 or so, I don't know  
23 how --

24 Q 1850 --

25 A That's about -- and  
26 what you see here, that is, over all those years,  
27 no one has ever measured a suction greater than  
28 1,000 centimeters of water and that corresponds  
29 to about 2,000 pounds per square foot, and those are  
30 just the pressures in the same ballpark as Dr.





1 Slusarchuk has measured in his tests in Calgary and  
2 in his laboratory tests.

3 Also, myself, I have been  
4 involved in measuring suction forces. When you allow  
5 a soil to heave, it is not a constant volume  
6 test but allow heaving. I don't believe that I  
7 have ever measured suctions greater than a half  
8 atmosphere.

9 Q What is that? What is a  
10 half atmosphere?

11 A An atmosphere would be  
12 1,000 pounds per square foot. I think I have visited  
13 many research laboratories, in many different countries.  
14 I have never met a scientist that would believe,  
15 I think, that the pulling forces off the frozen ground,  
16 on the water in the unfrozen ground is anywhere near  
17 54,000 pounds per square foot and I neither do I think  
18 that anyone has ever measured such enormous pulling  
19 forces.

20 THE COMMISSIONER: Do you  
21 say that no one has ever measured a pulling force  
22 greater than 1,000 pounds per square foot?

23 A You saw here on the  
24 chart that I showed you that the largest pulling  
25 force measured was -- corresponds to about 2,000  
26 pounds per square foot.

27 Q And you, yourself have  
28 never measured more than 1,000.

29 A Than 1,000 pounds  
30 per square foot, but that's, you know, that was on one



1 or two soils, so I might not have that right soil  
2 type.

3 MR. GENEST:

4 Q So do I take it then,  
5 Dr. Hoekstra that you fundamentally disagree with  
6 Williams' thesis that these pulling forces in a  
7 situation which we are going to be faced with, with  
8 this pipeline, are going to draw in water, unfrozen  
9 water from outside the frozen soil if the shutoff  
10 pressure necessary to prevent water coming in at  
11 the freezing front is applied?

12 A Yes, I believe those  
13 pressures are of the order of magnitude measured  
14 by the tests of Dr. Slusarchuk.

15 Q And if that shutoff  
16 pressure proposed by Dr. Slusarchuk is applied, you  
17 take the position that you will not have migration of  
18 unfrozen water from outside the freezing soil into  
19 the freezing soil.

20 A That is right, you will  
21 stop water flowing from the unfrozen into the  
22 frozen ground. You will not stop redistribution of  
23 ice in the frozen ground.

24

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Clark, Morgenstern, Slusarchuk,  
Harlan, Hoekstra  
In Chief

1 Q As to the redistribution  
2 itself, I don't know if that was clear or not, what is  
3 the engineering significance of the heave associated  
4 with the redistribution within the frozen soil?

5 A Well, I think Dr. Harlan  
6 is going to deal with that, but my position on that  
7 is that you rob Peter to pay Paul, in other words you take  
8 ice  
9 / away from one ice lens and put it on another place.

10 Q Dr. Harlan, you're next  
11 on my list anyway.

12 THE COMMISSIONER: Excuse me,  
13 so there is no heave?

14 A I don't think so.

15 MR. GENEST: Q Dr. Harlan, can  
16 I turn you to that subject? Well, perhaps I'd better  
17 let you go at it the way you were going to comment on  
18 hydraulic conductivity which was mentioned by Dr.  
19 Williams, and perhaps to set the stage, I should read  
20 from the transcript at page 10361, which is an excerpt  
21 of the transcript when Dr. Williams is being cross-  
22 examined by Mr. Marshall.

23 "Getting to the point I was about to raise, as I  
24 recollect it, was during Mr. Hollingworth's  
25 cross-examination, that you discussed rates at  
26 which water can move in frozen soil. You were  
27 asked a question about that and you made a  
28 reference to some research that had been done  
29 including some done by Dr. Harlan. If I under-  
30 stand the issue, sir, it's a question of the time  
over which this is occurring. My understanding





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is that the time scale is such that having regard to this project, it's really of no engineering consequence. That is the rate of migration of water through the frozen soil is so slow, given the time scale that we're concerned with here, this doesn't create a significant problem."

Answer:

"I don't agree. The values we have mentioned for hydraulic conductivity, they vary from soil to soil, but looking at my own graph you see values -- of course, it depends on temperature, but ten to the minus seven, ten to the minus nine, these are not terribly small permeabilities."

I'd like you to comment on that, sir, and then I'll ask you something about the rate of migration and what we were discussing about the significance on heave of redistribution, within frozen soils.

WITNESS HARLAN: O.K. The available evidence which we have and which is available from experimental observation and from the literature indicates that the hydraulic conductivity of frozen materials is extremely small. It can also be shown to decrease with temperature and with increase in ice content. In fact, if you look through the literature there are very few direct quantitative measurements of rates of mass transport in frozen soils. For this reason, Northern Engineering, specifically myself, has given considerable effort to calculating the



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1 effective hydraulic conductivities in frozen soil  
2 systems with time, based upon known thermal conditions  
3 and soil conditions.

4 The first slide, if I may have  
5 that, please.

6 On the first slide I show a  
7 number of things. Is it focused?

8 Q It's just a little bit  
9 fuzzy to me.

10 A How's that?

11 Q All right.

12 A What I have shown on this  
13 slide is the hydraulic conductivity for frozen materials  
14 ranging from  $1 \times 10$  to the minus 13, to  $1 \times 10$  to the  
15 zero centimeters per second.

16 Q I'm sorry, doctor, can we  
17 start at square one? What are we talking about when  
18 we're talking about hydraulic conductivity?

19 A Hydraulic conductivity  
20 is in effect the ability of a soil to transmit water.  
21 O.K., if you apply, like, a pressure gradient across a  
22 piece of soil, you can move water within the soil.  
23 The mobility of that water is given by the hydraulic  
24 conductivity.

25 Q And can you also move  
26 water through soils by temperature gradients?

27 A Yes, you can. There are  
28 a number of things that can initiate water movement.

29 Q Right.

30 A Temperature gradient being



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1 one, an osmotic difference, difference in salt concentra-  
2 tions is another. O.K., looking from observed changes  
3 in water content under known thermal conditions, we  
4 have calculated an effective hydraulic conductivity  
5 for both field and laboratory observations. The results  
6 of these calculations are indicated by the open  
7 circles, and they tend to fall in this range.

8 Q The circles -- from here  
9 they're dots.

10 A O.K. There's probably  
11 too much information on this. We can make xeroxes of  
12 the view graph. O.K., these are plotted as a function  
13 of temperature where there's minus 10 degrees at the  
14 top, and a very small temperature, a sub-freezing  
15 temperature --

16 Q On the right-hand side  
17 the temperatures are in degrees centigrade?

18 A Degrees centigrade.

19 Q And the horizontal line  
20 is the hydraulic conductivity expressed in centimeters  
21 per second.

22 A Yes.

23 Q Is that speed, is that the  
24 speed at which it moves?

25 A It's given as the  
26 velocity, yes.

27 Q As velocity.

28 A Yes.

29 Q And on the left side?

30 A On the left side is given





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1 what is soils physics terminology, as the water potential.  
2 It's equivalent to the suction force.

3 MR. GIBBS: What's the temperature  
4 range again?

5 A It's one-ten thousandths --  
6 it's minus 1/10,000ths of a degree, toward the centre is  
7 minus .01, minus 1 degree, and minus 10 degrees.

8 MR. GENEST: Q So these go up  
9 in orders of magnitude.

10 A They go up in orders of  
11 magnitude. O.K., I've also shown on the same graph  
12 the data points measured by Peter Williams and by his  
13 student, Timothy Burt, and these are indicated by  
14 the solid circles, points such as these. O.K., these  
15 were measured in the laboratory on artificial soil.  
16 O.K., they're shown both as a function of temperature  
17 and an equivalent suction.

18 The third point that is shown  
19 is the hydraulic conductivity for unsaturated non-  
20 frozen soils. O.K., these are obtained from the litera-  
21 ture, and the significant point is here, is the calc  
22 ted values, the observed values, and the values for  
23 hydraulic conductivity of unsaturated materials are  
24 of the same order, very similar.



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Q It is getting colder there  
as we go up?

So the point that I would like to re-emphasize is in frozen materials, once you get away from the zero degree isotherm, into the frozen zone, there is a very drastic decrease in the hydraulic conductivity.

A Yes.

A Yes.

In other words, if we have a constant energy gradient or pressure difference, then as the temperature goes down, the rates of water migration decrease by orders of magnitude.

MR. GIBBS: Mr. Commissioner,  
I am still somewhat confused by this. I wonder if  
the witness could trace one of his curves and tell me  
what is happening as the temperature decreases.

A      Okay, maybe I could, as Dr. Hoekstra mentioned, there is a relationship between temperature and the suction forces.



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1 Okay, at cold temperatures  
2 we have very strong suction forces developing. Dr.  
3 Hoekstra alluded to --

4 WITNESS HOEKSTRA:

5 A Could I ---

6 WITNESS HARLAN:

7 A Yes.

8 WITNESS HOEKSTRA:

9 A In other words when you  
10 lower the temperature, you lower the amount from  
11 frozen water, very close to the freezing front, say,  
12 you might have a film thickness of say 10 to the minus  
13 seventh and you lower the temperature, it immediately  
14 it falls off very steeply. A water movement would have to  
15 flow to that film.  
16 So the smaller silt test the lower the permeability,  
17 so when you lower the temperature it almost comes  
18 down exponentially, or it does go down exponentially.

18 THE COMMISSIONER: Excuse me.

19 This suction, at least the pulling force increases  
20 as the temperature goes down, but the permeability of  
21 the ground lessens so they tend to counteract  
22 each other.

23 WITNESS HARLAN:

24 A No, they are both in  
25 the same direction.

26 WITNESS HOEKSTRA:

27 A Well, depending on if  
28 one goes down faster than the other. It turns I think  
29 that the permeability goes down a lot faster than  
30 the suction forces, because here we are not dealing





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1 with suction forces. We are only dealing with permea-  
2 bility.

3 THE COMMISSIONER: Oh, I  
4 understand that.

5 A Okay, yes, it is a  
6 product of the two.

7 Q I take it that the  
8 point you are driving at here is that Williams has  
9 not taken into account the extent to which permeability  
10 decreases as the temperature decreases and  
11 Dr. Hoekstra says it actually decreases faster and  
12 is a more important factor than the increase in the  
13 pulling forces owing to the decrease in the temperature.

14 A Yes.

15 Q Am I summarizing fairly  
16 the point that you people are driving at here?

17 WITNESS HARLAN:

18 A Not really, in that  
19 we are in fact using Dr. Williams' data in this  
20 area.

21 Q Well, leaving aside his  
22 data, the way in which I have expressed this whole  
23 thing, is that doing rough justice to it or not?

24 A I think it will probably  
25 become clearer as we go on.

26 THE COMMISSIONER: All right.

27 MR. GIBBS: I am  
28 still confused about these curves. As the temperature  
29 gets colder the permeability stays the same, is that  
30 right, up to about one third of the way up your chart --



1 A Yes, this is

2 Q And at that point it  
3 starts, the permeability starts to decrease as the  
4 curve curves over to the left?

5 A That is correct.

6 This is at a temperature of  
7 minus  $1/100$  of a degree Centigrade, so in effect the  
8 temperature is very close to  $0^{\circ}$  Centigrade. Okay, so  
9 it does not take much of a freezing point depression  
10 before the hydraulic conductivity is reduced many  
11 orders of magnitude--

12 MR. GENEST: Well, that is  
13 the point that I wanted to make. As the curves  
14 flatten and move towards the left, the hydraulic  
15 conductivity is reducing in orders of magnitude. It  
16 is not just -- I may be a little misled by the slope  
17 of those curves because I can't read the bottom --  
18 I read it sometime yesterday and I forgot --

19 A Yes, well, this is  
20 going from ten to zero --

21 Q Let's take your first  
22 curve on the right. That is going -- it starts -- what  
23 is the number on the bottom there?

24 A Ten to the minus one.

25 Q Right, and would you  
26 trace its progress?

27 A Okay. At minus  $1/10,000$ th  
28 of a degree it is essentially unchanged. As we move  
29 up to minus  $1/100$ th of a degree Centigrade we have  
30 decreased to almost  $10^{-4}$  centimeters. So there is a  
two order magnitude of decrease over that range.



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1 If we move up to minus 1 degree,  
2 centigrade, we're talking  $1 \times 10$  to the minus 7, so that  
3 again there's a three order of magnitude. O.K., as  
4 you progress to colder temperatures, there is an even  
5 greater degree in hydraulic conductivity.

6 MR. GIBBS: Can I come in here  
7 once more, sir, please? Do I take it from that that  
8 on, where you have the pulling force on the left, as  
9 the temperature decreases and the permeability decreases,  
10 at the same time the pulling forces increase, but in  
11 your upper left-hand corner is where they cancel each  
12 other out, as Dr. Hoekstra spoke. Is that the indication  
13 from that?

14 A I'm not sure I quite  
15 understand your question.

16 MR. GENEST: Well, maybe I can  
17 help, doctor, because I'm -- I'm suffering from  
18 the same problem as the Commissioner and Mr. Gibbs is.

19 Q What do you establish  
20 here, and maybe that's all you want to do right now,  
21 is that as temperature decreases conductivity decreases  
22 dramatically.

23 A Yes, this is the point  
24 we want to establish at this point.

25 Q Well, that's just the  
26 point, because I think what is concerning us all is  
27 what meaning does that have in connection with the  
28 forces that Dr. Williams has described as having  
29 a significant effect on heave. Are you going to come  
30 to that or --

A Yes we are.





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Q In due course.

So we should all be quiet  
and listen to you, and then ask the question again if  
it hasn't been explained.

A Right.

As is expressed here, there's  
nothing to suggest rates of movement other than this  
is the potential mobility of water if you are given  
a gradient. If there is no temperature gradient  
across the sample, then we would not initiate movement.

Q Could I have that again?

A O.K., what this graph  
shows is the relationship between hydraulic conductivity  
and temperature.

Q Right.

A There is nothing in this  
graph itself to suggest rates of movement.

Q All right. I'm with you.  
You may proceed.

A O.K., in general we can  
say that the hydraulic conductivity of a frozen soil  
is determined by the thickness of the unfrozen film.  
We can see from this that as the thickness of the film  
decreases, O.K., as temperatures become colder, the  
hydraulic conductivity decreases significantly. It's  
also dependent to some degree on the surface area of  
the soil. I should have added, these figures are for  
fine-grained soils, being silts and clays.

Q The worst soils from a --



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1 A From a frost-heaving point  
2 of view. If we're dealing with gravels, the curves  
3 become way to this side, they are much, much smaller.  
4 So this is in effect a worst case situation.

5 The third thing, when you're  
6 dealing with real soils the hydraulic conductivity is  
7 also dependent upon the torch velocity(?) the path in  
8 which flow must follow, as well as the continuity of  
9 the film. I think this point will become clear in  
10 the next, several slides.

11 O.K., as a visual demonstration  
12 of frost-heaving phenomenon, Dr. Williams cited an  
13 example from a paper by Dr. Hoekstra, and on page 516  
14 of this paper, the following statement is found:

15 "The rate of flow depends upon the temperature  
16 and surface area of the soil, and the continuity  
17 of films through the frozen soil matrix. Ice  
18 lenses will disrupt the continuity and will  
19 block water migration."

20 Q It creates a maze, is  
21 that what you're saying, and it's harder to get around  
22 the maze?

23 A If it forms an ice lens,  
24 then the water must migrate also around that ice lens.  
25 So it has an effect on reducing the effective hydraulic  
26 conductivity. There is photographic evidence of this  
27 available in Hoekstra's paper. May I have the next  
28 slide, please?

29 This is the example in which  
30 Dr. Williams used. It involved a soil column, a freezing



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1 plate which is given here --

2 Q At the bottom.

3 A -- at the bottom.

4 Q And that was Dr. Williams'  
5 chart what?

6 A Well, he presented one  
7 slide.

8 Q One slide, all right.

9 A This is a different set of  
10 photographs, but of the same experiments.

11 Shown here the freezing front  
12 is in this area. There is a slight color change. There  
13 is an ice lens forming at or very close to that freezing  
14 front. There is also an ice lens visible behind this  
15 freezing front. If you go through time -- may I have  
16 the next slide, please -- we note that the ice lenses  
17 closest to the freezing front increases in size, but  
18 the one behind the freezing front does not.

19 Q Maybe I may just clear it  
20 up here, where is the warmer -- where is the temperature  
21 more high?

22 A This is the cold plate  
23 at the bottom.

24 Q At the bottom, so that it's  
25 warmer nearer the top.

26 A Yes.

27 Q All right, and the freez-  
28 ing front is at the broken line.

29 A The freezing front is  
30 advancing upwards.





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1 Q What you're saying is  
2 that the growth of the lens in the middle of the picture  
3 appears towards the top, but not towards the bottom.

4 A That's correct.

5 Q All right.

6 A In the lens closest towards  
7 the freezing front, as the lens closest to the freezing  
8 front continues to grow, but the lens behind that  
9 freezing front does not. This point will be more  
10 clear in the third slide.  
11  
12  
13  
14  
15  
16  
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29  
30



1 This lens is essentially  
2 the same size whereas this one has grown very signif-  
3 icantly. So this provides visual evidence of the  
4 effectiveness of ice lensing in reducing the  
5 hydraulic conductivity of frozen materials.

6 Okay, this point was not  
7 taken into account in Dr. Williams' evidence.

8 MR. GIBBS: How does it  
9 show that?

10 MR. GENEST: By looking at  
11 the bottom of the ice lens.

12 A It may be worthwhile  
13 to back up and go through the sequence again.

14 WITNESS HOEKSTRA:

15 A Here is the cold plate,  
16 right? This is the warm plate, it is plus five degr  
17 here. Here where you have the colour change is the  
18 freezing front, so there is no question that this  
19 ice lens as we go through sequences grows inside,  
20 so there is movement in the frozen ground. But the  
21 point I think that we want to make is that this  
22 ice lens blocks waterflow to that one so that the  
23 ice lens is like a metal plate, nothing can go through  
24 it because water cannot flow through ice. Water  
25 can only flow through unfrozen film -- so can  
26 we go to the next slide --

27 MR. GIBBS: The lens  
28 creates an impermeable barrier.

29 A The lens is an imperme-  
30 able barrier and if you have just this unfrozen ground



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1 with ice lenses in there, its permeability will go  
2 to zilch, and that is what you see it is here. Here  
3 freezing front is here. This one grows in the frozen  
4 ground, this one water movement to it is blocked by  
5 that ice lens, it does not grow and the next  
6 slide amplifies that.

7 WITNESS HARLAN:

8 A Okay, are we clear on  
9 that point ?

10 MR. GIBBS: Yes, I was wondering  
11 if he would spell "zilch", but otherwise --

12 MR. GENEST: It is a Dutch  
13 scientific term.

14 (LAUGHTER)

15 WITNESS HARLAN:

16 Okay, the extent to  
17 which ice lensing affects the hydraulic conductivity  
18 of frozen materials is also shown by measurements of  
19 electroresistivity.

20 THE COMMISSIONER: Well, it  
21 is 12:30, why don't we stop for lunch and come back  
22 at two and carry on now that we have safely gotten  
23 thus far.

24 (PROCEEDINGS ADJOURNED)  
25  
26  
27  
28  
29  
30





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(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

MR. GENEST: May I proceed,  
Mr. Commissioner?

THE COMMISSIONER: Yes, certainly.

MR. GENEST: Q Dr. Harlan,  
at the lunch break I think we had concluded your  
treatment of the subject of hydraulic conductivity,  
as illustrated by the graph that you showed. Are there  
other scientific approaches that arrive at the same  
result?

WITNESS HARLAN: Yes, they are  
Perhaps maybe the best way, just to summarize what we  
said this morning in very brief terms, we showed by  
means of the graphs, that the hydraulic conductivity of  
a frozen soil decreases very significantly with  
decrease in temperature, from say for example from  
minus 1 degrees to minus 10 degrees Centigrade, the  
hydraulic conductivity decreases 10 to 15 orders of  
magnitude. We also tried to show by means of an  
example the three, the sequence of slides from one-  
column experiment that would be the occurrence of  
ice lensing, the continuity of the films, and the  
hydraulic conductivity is further decreased. There is  
other evidence for example, as I mentioned right before  
lunch, electrical resistivity measurements that show  
the same things. Some of the work by Dr. Williams and  
also his student, Timothy Burt, also show a very  
significant decrease in hydraulic conductivity with  
the occurrence of ice lensing.

Q Well then, let me take



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1 then to the -- to where that leads us. There are pulling  
2 forces within the frozen soil --

3 A That is correct, yes.

4 Q -- caused by thermal  
5 gradients.

6 A Yes.

7 Q And let me put this case  
8 to you. First let us assume that there is no migration  
9 of water from outside the frozen soil into the frozen  
10 soil, and what we are dealing with are the heaving  
11 pressures of the movement of ice or water or whatever  
12 it is, within the frozen soil caused by the pulling  
13 forces that exist therein. What is the effect of  
14 that on heave?

15 A O.K., perhaps to back  
16 up slightly, the movement or mass transfer in frozen  
17 material is the product of two things:

- 18 (1) the temperature gradient, and  
19 (2) the hydraulic conductivity.

20 So without a temperature  
21 gradient you will not have redistribution in this  
22 context. If we look at just a piece of frozen soil,  
23 the ice will tend to be redistributed through that  
24 system from the warm to the cold side. The rate at  
25 which this occurs will be dependent upon the magnitude  
26 of the temperature gradient, and the hydraulic  
27 conductivity.

28 O.K., there are two aspects  
29 of this which should be considered:

- (1) we can redistribute ice lenses from, for example,



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1 the warm side to the cold side. If this occurs, there  
2 is effectively no change or very little change in the  
3 total volume in the system.

4 Q That's doing what Dr.  
5 Hoekstra described as robbing Peter to pay Paul.

6 A That's correct.

7 Q No net heave.

8 A No net heave. So it's  
9 just a redistribution of ice within the system.

10 Q Right.

11 A O.K., if the process goes  
12 on long enough, it is possible to desaturate, in other  
13 words, create void spaces on the warm side. So that  
14 the ice that was contained within these spaces, for  
15 example between soil particles --

16 Q You could draw the ice  
17 out of that particular section of soil and thereby--  
18 that's what you call desaturation.

19 A Yes.

20 Q I suppose you could leave  
21 a void.

22 A Leave a void or fill it  
23 with air.

24 Q All Right, what would  
25 happen then?

26 A In this situation you  
27 could -- the end result could be a net increase in  
28 volume or a heave.

29 Q A heave. Now, what we're  
interested in, I think, is what is the effect of that



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1 heave? What is the significance of that heave in  
2 engineering terms?

3 A In view of the volume  
4 changes involved, and also the very slow rate at which  
5 this process would occur, it is, in my opinion, of  
6 no engineering consequences.

7 Q Dr. Morgenstern, do you  
8 agree with that?

9 WITNESS MORGENSTERN: Yes/sir,  
10 I do.

11 Q Is there, if we expand  
12 our time scale, would there or could there be a notice-  
13 able effect brought about by this kind of migration?

14 WITNESS HARLAN:

15 A In terms of the geologi-  
16 cal time scale, yes.

17 Q What kind of a time scale  
18 are we talking about there?

19 A We're talking in terms  
20 of thousands, tens of thousands of years not  
21 within say an engineering life of a pipeline.

22 Q Now, turning to this  
23 question of migration again, and conductivity, through  
24 another set of assumptions let us assume that Dr.  
25 Williams is right and that the presence of the forces  
26 within the frozen soil is sucking in from outside some  
27 water, it's forcing some water from -- some water in  
28 unfrozen soil to migrate past the freezing front and  
29 into the frozen soil, what would be again the engineer-  
ing significance of heave produced by that method?

A In my opinion, the heave





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1 produced by this method would be of no engineering  
2 significance. My reasoning for this is that the rates  
3 or the process is controlled by the rates of motion  
4 migration within the frozen zone under the thermal  
5 gradients/<sup>in</sup> which we would expect, and also in view of  
6 the very low hydraulic conductivities, these are just  
7 negligible rates within an engineering context.



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1 A I might add  
2 that if one accepts Dr. Williams' view that there  
3 are significant rates of water migration within  
4 frozen soil, then one would anticipate that in permafrost  
5 terrain under the existing geothermal gradient we  
6 would have a regional uplift.

7 Q That would be observable?

8 A Well, if these rates  
9 are significant.

10 Q If Dr. Williams is  
11 right we would be able to observe heaving in a natural  
12 state in permafrost, is that what you are saying?

13 A That is what I am  
14 saying, yes.

15 Q In other words, should  
16 Inuvik be rising up?

17 A This is what I am implying,  
18 if Dr. Williams is right. It should be rising at an  
19 observable rate. I am not aware of any measurements  
20 that would indicate that this is true.

21 Q Perhaps we can deal with  
22 that when we go to Inuvik.

23 THE COMMISSIONER: We will see  
24 what Father Adams thinks.

25 MR. GENEST: I wasn't going to  
26 talk about uplift.

27 Q Dr. Slusarchuk I would now  
28 like to turn to the criticism of Dr. Williams, as I  
29 understood his evidence he criticized the usefulness  
30 and the accuracy of the experimental work at the



1 Calgary test site in the laboratory and I want to deal  
2 with each of them in particular. I believe the first  
3 one -- or at least the first one I would like to  
4 deal with appears at page 10329 of the transcript,  
5 in these words and I am reading from line two, he  
6 says in answer to a question:

7 "Well, they [meaning N.E.S.] have gone  
8 at it empirically and totally ignored  
9 a considerable body of knowledge which  
10 I tried to introduce this morning on  
11 the states of stress in the water in  
12 the frozen soil and so forth."

13 And I think that is repeated elsewhere. He is  
14 alleging that you have ignored a large body of well  
15 settled experience. Could I have your comments on  
16 that

17 WITNESS SLUSARCHUK:

18 A Yes, I disagree with  
19 Dr. Williams on this point. I have personally been  
20 aware of much of the frost heave work that has been  
21 going on in the past ten years and have read much  
22 of the great amount of available literature which  
23 is much more voluminous than indicated by Dr. Williams'  
24 lists which are entered as exhibits 273 and 274. I  
25 have discussed these matters with people involved in  
26 frost heaving such as Mr. Ed Penner and Dr. Lorin  
27 Gold, both of the National Research Council of  
28 Canada.

29 THE COMMISSIONER: I wonder  
30 if you could spell both of those names while we are --





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1 A Penner, P.E.N.N.F.R.,  
2 Gold, G.O.L.D.

3 THE COMMISSIONER: Both with  
4 the National Research Council.

5 A Both of the National  
6 Research Council of Canada; Dr. Ross McKay, who  
7 was an overview witness before this Commission. Dr.  
8 Bob Miller from Cornell University who is referred  
9 to by Dr. Williams in his testimony; Dr. Dwane Anderson  
10 from the Cold Regions Research and Engineering Labora-  
11 tories in Hanover, New Hampshire; Dr. Ray Yong  
12 from McGill University; and Dr. Paul Gaskin from  
13 Queens University who, incidentally, was interested  
14 enough in our work to join us in July 1975 for one  
15 year while on sabbatical leave from Queens. In addition  
16 I had correspondence with Dr. Harlan on this subject  
17 before he joined our company over a year and a half  
18 ago. Clearly there has been input from Dr. Morgenstern,  
19 Dr. Clark, Dr. Hardy, and staff members of Northern  
20 Engineering such as Mr. Wayne Arvidson who  
21 completed a Masters program at the University of  
22 Alberta on frost heaving in 1973 and Drs. McRoberts  
23 and Nixon, both of whom are trained and experienced  
24 in aspects related to freezing and thawing of soil.

25 In addition I have discussed  
26 frost heaving with Dr. Williams at various times over  
27 the past four to five years and I have visited his  
28 laboratories at Carleton University .

29 Our frost heave program  
30 was arrived at with full awareness of the state of



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1 the art after consultation with several authorities  
2 in this field and in my opinion it represented the  
3 best methods of analysing frost heave as it affected  
4 the proposed pipeline.

5 I therefore reject Dr.  
6 Williams' contention that we have totally ignored a  
7 body of literature, although some of the results in  
8 the literature show that the rate of heave would be  
9 reduced by applying surcharged loadings, there was  
10 no comprehensive theory available that we could  
11 use to predict the heave of our pipeline. That  
12 is why we initiated our frost heave program.

13 THE COMMISSIONER: Dr. Slu-  
14 sarchuk, You are not suggesting that you talked  
15 to all of these people about the proposition Dr.  
16 Williams put forward when he testified here two  
17 or three weeks ago? You are saying that over the  
18 last few years in preparing the Arctic Gas scheme,  
19 all of these people have in one way or the other been  
20 consulted either through reading the stuff they  
21 have written or talking to them or bringing them in  
22 to work for your company?

23 A Yes, sir. The latter --

24 Q The people that you  
25 consulted about the Williams critique are your  
26 colleagues at the table I assume.

27 A Yes, I also went to  
28 Ottawa, I guess it was about a week ago and discussed  
29 the matter with Mr. Ed Penner at that time too.

30 Q Of the National Research



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1 Council.

2 A Of the National Research  
3 Council.

4 Q And what is his -- what  
5 are his qualifications for discussing frost heave?

6 A he has been involved in  
7 the frost heave work in Canada probably longer than  
8 anybody else, other than maybe perhaps Dr. Hardy

9 In my view he has considerable stature in frost  
10 heaving, not only in Canada and the United States,  
11 but throughout the world, and one of the reasons that  
12 I went down to consult with him was not simply to  
13 discuss the proposition that Dr. Williams had put  
14 forth but was to bring him up to date on the results  
15 of our studies. We consulted him at the very --  
16 before we had set out our program. We told him what  
17 we were going to do. We discussed it with him and  
18 from time to time I have kept him informed about  
19 what was going on.  
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1 I have sent him copies of  
2 our reports and I went down there to discuss with him  
3 the overall frost heave situation as it was affecting  
4 us at that time.

5 THE COMMISSIONER: Well, did  
6 he have any views on Williams' critique of the  
7 Arctic Gas approach?

8 A Well, he did have views  
9 and I'm not sure whether I should comment on his views  
10 or not.

11 Q Well maybe -- he doesn't  
12 work for you, does it?

13 A He does not work --

14 Q Is he a consultant to you?

15 A No, he's not.

16 Q He's working for the  
17 National Research Council?

18 A He is, sir.

19 Q Well, maybe you should  
20 get in touch with him, Mr. Scott, Mr. Goudge. He's  
21 a very eminent figure in this field in the world, I  
22 take it, from what you say.

23 A Yes sir.

24 MR. GENEST: Unless, Dr.  
25 Slusarchuk, you have objection on confidential grounds,  
26 to relating what Dr. Penner's views were, I have no  
27 objection. Mr. Scott, I'm sure, will follow up.

28 A Well, my interpretation  
29 was that he didn't believe that such large forces would





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1 be required to stop the frost heaving. I asked him  
2 specifically if he thought that our method was reasonable  
3 and he suggested that he thought it was, and we had  
4 previously asked him if he could assist is in any way  
5 by giving us advice on another way to go about predict-  
6 ing these rates of heave and the amount of heave of  
7 our pipeline, and he has told us that he knows of no  
8 other way. That's my summation of his views.

9 Q Well then, next, sir,  
10 next, Dr. Williams, I think that's really his central  
11 attack on your conclusions from your experiments, he  
12 suggests that the heave predicted by your method will  
13 under-estimate that experienced by the pipe in the  
14 field, and moreover, that the surcharge loading compat-  
15 ible with your shutoff pressure will be ineffective  
16 to suppress heave. Would you comment on that?

17 A Well, if I may I'd like  
18 to bring this Commission up to date on the results  
19 of the Calgary frost-heave test facility. It now has  
20 been in operation for 1 1/2 years. A particularly  
21 interesting feature of these results is what happened  
22 after we placed a 5-foot surcharge berm on two of the  
23 four buried sections in June, about three months ago.  
24 I'd just like to show the results, the actual heaves  
25 that we're measuring, and how we're predicting them.

26 THE COMMISSIONER: Go ahead.

27 MR. GENEST : Q Would you  
28 go ahead?

29 A Just quickly to refresh  
your memory, we have the four buried test sections at the



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Calgary test-site, each one, each test section is four feet in diameter, the same sized pipe as what we're proposing, of course, and each section is 40 feet long. Now this is a graph of predicted and observed pipe heave at the control section. I want to go through each, the predicted and observed pipe heave for each section.

The control section was buried such that the top of the pipe was about 2 1/2 feet beneath the original ground surface. Along this axis I have heave, the amount of heave of the pipe, the total heave of the pipe in feet, and this here is one foot here. Along here we have time in months, from the start of our test in March 20 , 1974, and in here during June is the time that we applied our 5 foot berm application to the -- on top of the control section, and I'll get you those results in a second. Now on here you'll see three lines. You'll see the solid line which is called the observed heave of the pipe; and you'll see two dashed lines, one method 1, and another method 2, and these are predicted heaves. Method 1 and method 2 are based on exactly the same principles, it's just a matter of geometry how we handled one or the other. Method 2 is a simplified method of predicting compared with method 1. In Method 1 we actually account for the real shape of the frost bulb, and the sheering resistance along the -- between the frozen bulb/<sup>that is</sup> moving up and the soil along the unfrozen soil that is moving up through. Method 2 we ignore that sheer and assume that the frost bulb is



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1 rectangular at the bottom. It's just a matter of  
2 detail. I don't want to discuss method 1 and method 2  
3 any more than that, to say it's just a small matter  
4 of detail there.

5 Now, here you'll see that  
6 the observed heave rate as the frost bulb started to  
7 get deeper and deeper, starts to become smaller, the  
8 heave rate decreases with time as the frost bulb  
9 gets a little bit deeper. That is in agreement with  
10 our idea of overburden pressure reducing the rate of  
11 heave.

12 At this point we put our five  
13 foot berm application onto the control section and  
14 we had this amount of settlement or consolidation.  
15 That was simply due to the fact that we put the extra  
16 load on it and it was the unfrozen soil around that  
17 simply settled. Then almost immediately over two or  
18 days, this then was the observed heave. You can see  
19 that before the average heave rate, the rate that the  
20 pipe was heaving up before the berm application was at  
21 about that rate, and that after the five foot berm  
22 application there was heaving at about that rate.  
23 This again is according to our views that overburden  
24 pressure should reduce the rate of heave of the pipe.

25 Now, here is our predictions.  
26 Now from my view, this is a very good prediction over  
27 this period of time, and the point that I want to  
draw you to is that at later times, at longer periods  
of time we are over-predicting the rate of heave.  
We're measuring heave rates at that rate and we're





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1 actually predicting them at that rate. Again after the  
2 berm was applied, we're measuring heave rates at that  
3 rate and we're actually predicting heave rates at that  
4 rate. This is an exact opposite view that Dr. Williams  
5 holds. He says that with longer periods of time our  
6 shutoff pressures becomes greater and our heave therefore  
7 should become more. So we are finding this to be quite  
8 different in actual fact in the field than from what  
9 Dr. Williams has suggested.

10 Q These -- I'm sorry, could  
11 you just keep that up a moment longer -- these are you  
12 observed results until when, until October?

13 A Until about the middle  
14 of September.

15 Q Of September of this  
16 year?

17 A Of this year, yes.

18 I'm not numbering these.  
19 I'm referring to the title down at the bottom, Mr.  
20 Goudge, do you think that will be good enough?

21 Predicted and observed pipe  
22 heave at the deep burial section, the deep burial  
23 section the pipe was buried such that the top of the  
24 pipe was five feet, 5 1/2 feet beneath the original  
25 ground surface.  
26  
27  
28



1 In other words, it was  
2 buried an extra three feet deeper than the control  
3 section. You can see that just for example it is  
4 kind of a confusing picture.

5 Q You are superimposing  
6 your -- the last slide with the one that you are  
7 presently showing.

8 A Yes, I just want to  
9 draw attention to two lines here. This is the  
10 observed heave rate of the control section and here is  
11 the observed heave rate of the deep burial section  
12 which was buried three feet deeper.

13 I have the same co-ordinates  
14 on all of these figures. I am not going to go over  
15 them each time. Here is the solid line again  
16 showing the observed. We applied our berm application  
17 load here and then you can see that it was heaving  
18 somewhere at a rate like that before we put the  
19 berm on and now it is heaving at a rate something  
20 like that.

21 Our rates of heave of prediction  
22 towards the end before we put the berm on were pretty  
23 close to the same as what we actually observed except  
24 a little bit higher, but after we put the berm on  
25 it though, we're predicting that heave would be occurring  
26 at a little bit faster rate than we are actually  
27 observing.

28 This is our restrain  
29 section. We are not predicting as well here as  
30 you can see as we predicted in the other two --



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Q Can you refresh our memory  
as to what the restrain section is, Dr. Slusarchuk?

A Yes, excuse me. The  
restrain section was a section where the pipe was  
buried, the top of the pipe was two and a half feet  
beneath the nominal ground surface and we had jacks  
that we could put a load on the pipe, but the jacks  
were such that they could move under a constant load  
so we would simply put a certain load on as we liked  
on to the pipe which would then be transferred onto  
the freezing front, so the idea was to put different  
loads onto the freezing front on the restrain  
section.

We started out in March of  
'74 and we were sort of heaving our rate about like  
this -- we applied a load here, 56 tons, and over  
the frost bulb at that time, and you have to appreciate  
that the frost bulb is continually getting larger all  
the time. We put one load on and at that time,  
the 56 tons was almost equivalent to say putting a  
three foot surcharge berm on top of it.

You can see that when we  
put that loading on, it did tend to change the rate  
of heaving. We then applied 186 tons at this  
stage and I can't quite remember, the frost bulb had  
grown, I can't quite remember how many -- equivalent  
to how many feet of over burden that was, at the  
moment, but we started heaving at a rate like that.  
Later on we applied 380 tons and there was not a  
great amount of change in the rate of heave at that time.



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1 We were coming into the winter months here and the  
2 frost bulb was getting a little bit larger at the  
3 sides, the frost bulb was growing a little bit more  
4 and the average stress on the frost front was decreasing  
5 with time. We kept the load constant.

6 Now, at this point we applied  
7 a fairly large load coming pretty close to the  
8 shut off pressure, still a little bit under.  
9 When we applied that load, the load that we calculated  
10 on the frost front was something like 2,600 pounds  
11 per square foot and the soil there, we have determined,  
12 had a shutoff pressure of 3,000 pounds per square  
13 foot, so we are coming close to the shutoff pressure,  
14 but still under it. You can see that the average  
15 heave over that last period of time certainly has  
16 dropped off and that this is flattening out.

17 Between this period of time  
18 here -- I can't tell you just exactly how much heave  
19 took place, but I do know that there's almost  
20 one half of the heave that took place in that period  
21 of time was due to lensing heave, the other half  
22 was due to the expansion of the in situ soil as  
23 the frost front just got a little larger and froze  
24 the soil particles that were already -- froze the  
25 water in pores between the soil particles themselves.

26 Now, as I mentioned earlier,  
27 we are not predicting as well in this case as we  
28 did before. We are over predicting. This is -- I  
29 would be a lot happier if we were predicting closer  
30 from the point of view of maybe not having to be so





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1 conservative in our design measures, but our methods  
2 are all showing that we are overpredicting what we  
3 are finding. In other words, we developed a laboratory  
4 testing program to get our frost heave characteristics,  
5 a method of analysis and the way that we put it  
6 together is a conservative way so that we always  
7 end up estimating more heave than what we are  
8 observing.

9 Again, I would like to draw  
10 your attention to the fact that we are predicting  
11 that we should be heaving at a rate about like that,  
12 and we are observing a rate something like that.  
13 Again, in the long period of time this is contrary  
14 to what Dr. Williams is expecting should be  
15 happening.

16 Finally, this is the gravel  
17 section and again we are predicting over by quite a  
18 bit. We haven't surcharged this one. We are now  
19 trying to look into the exact reasoning why we are  
20 overpredicting so very much in that area, but the  
21 fact is that our method is conservative. We are  
22 going to be doing more work on looking at the  
23 conservative nature of it, but the way it sits  
24 right now we have a conservative method for predicting  
25 heave.

26 In general, I believe that the  
27 results that I have just shown, which span a period  
28 of a year and a half, are convincing evidence that  
29 our method of prediction is acceptable for pipeline  
30 engineering purposes. We over predict as time goes



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1 along and that is the opposite to what Dr. Williams  
2 suggests. He believes that the shutoff pressures and  
3 hence the amount of heave would be greater than  
4 what Northern Engineering is predicting.

5 Some of the more recent  
6 work done by Dr. Bob Miller of Cornell University  
7 who is referred to by Dr. Williams as a, in quotes:  
8 "A very distinguished worker in the field" --

9 THE COMMISSIONER: Do you  
10 agree with that?

11 A Yes, I do.  
12 -- has shown the shut off pressure decreases as the  
13 thermal gradient decreases. Let me go through that  
14 again -- has shown that the shutoff pressure  
15 decreases as the thermal gradient decreases for the  
16 range of thermal gradients that we will have through  
17 the frozen soil around our pipeline. In simple terms  
18 this means that as a frost bulb grows larger, the  
19 shutoff pressures become smaller.

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1 As the thermal gradient gets  
2 smaller, the frost bulb becomes larger.

3 THE COMMISSIONER: That's what  
4 you say Dr. Miller's experiments have shown?

5 A Yes sir.

6 This agrees with our observed  
7 results at the Calgary test facility, in other words  
8 what Dr. Miller's lab results have shown. They agree  
9 with what we're observing at the Calgary test facility,  
10 and again it's opposite to what Dr. Williams is  
11 suggesting, when he says that our shutoff pressures would  
12 increase with time, and the ones we are measuring and  
13 using are much too low.

14 MR. GENEST: When  
15 you're seated I want to move onto another criticism  
16 of Dr. Williams as to your experimental methods. I be-  
17 lieve<sup>he</sup> suggested that your test results were unreliable  
18 because their duration was too short, that if they had  
19 gone on longer you would have observed far different  
20 results. Can you comment on that?

21 A Yes. I totally disagree  
22 with this point. Dr. Williams views do not accord  
23 with the recent results reported by Dr. Miller from  
24 Cornell University which indicates that the shutoff  
25 pressure decrease if the thermal gradients decrease.  
26 Our thermal gradients decrease with time because the  
27 size of our frost bulb increases, just as I got finished  
28 saying before.

29 We have looked at other  
30 experimental results as well. The first tests that





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1 were carried out in a manner similar to ours were those  
2 of Arvidson and Morgenstern --

3 Q How do you spell that  
4 first name?

5 A Arvidson, A-R-V-I-D-S-O-N,  
6 and Morgenstern --

7 Q Morgenstern, he's our  
8 Dr. Morgenstern.

9 A The very same, and the  
10 duration of those tests was about three hours. We  
11 ran our tests about 20 times as long. We checked the  
12 field results over three-day intervals, which was  
13 240 times as long, and finally we checked our results  
14 over 18 months of testing at the field test-site, which  
15 is over 4,000 times as long as the original test.  
16 All of these results give heave rates and shutoff  
17 pressures in the same range. We believe that if we  
18 extrapolate the performance over 20 years, which would  
19 increase our largest time factor by only 13 times,  
20 that we will obtain the same results.

21 Q Is an extrapolation of  
22 this kind considered reasonable in engineering work?

23 A I believe it is.

24 Q Dr. Morgenstern?

25 WITNESS MORGENSTERN: Yes,  
26 particularly when you have measurements going back  
27 several orders of magnitude prior, and then you plot  
28 your phenomenon on these different orders of magnitude  
29 of duration, the curve is very flat so that the pro-  
30 jection one more order of magnitude is very



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1 reasonable. We do it all the time.

2 Q Next, Dr. Slusarchuk,  
3 at page 10367 of the transcript there is a discussion  
4 about the incompatibility of the actual results, we  
5 have the observed results from the field test-site  
6 with Williams' -- Dr. Williams' position. Perhaps I  
7 should read it. In the cross-examination by Mr. Marshall  
8 at page 10367, line 8:

9 Question:

10 "Well, sir, the reason we get into it is that I  
11 understand that the Northern Engineering engineers  
12 in their research that they have conducted in  
13 Calgary have not been able to detect any heave  
14 associated with these temperatures lower than  
15 30 degrees. At the site where they have been  
16 running the tests for some 18 months, and the  
17 heave gauges behind the 30 to 32 degree range,  
18 don't demonstrate that there is any heave  
19 occurring there and that is why we have this  
20 difficulty with your suggestion."

21 Answer:

22 "Well, I don't know, one year --

23 Q 18 months.

24 A 18 months. Heave gauges, you know, I don't  
25 want to suggest any kind of sort of incompet-  
26 ence or anything like that, but that kind of  
27 paradox, if it is really clearly there, does  
28 exist very frequently and one would want to  
29 know why.

30 I agree that if you are



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1 really sure that those heave gauges are really  
2 accurate, it might be very interesting to ask  
3 why precisely nothing has happened, but I don't  
4 believe actually that the reason that heave  
5 gauges are milled to a thousandth of a degree.

6 Q Dr. Slusarchuk has the results here, if you  
7 want them.

8 A Well, I would be interested in seeing them."

9 First of all, Dr. Slusarchuk,  
10 perhaps, I'm being unfair to Dr. Williams, he may not  
11 have intended this, but I received the impression that  
12 he doubted the accuracy of our measurements or the  
13 competence of the people who were measuring them. Could  
14 you tell us about the accuracy of the measurements and  
15 how we go about it? And whether you have any doubt  
16 about the measurements themselves?

17 WITNESS SLUSARCHUK: Yes.  
18 I should like to say that we have had skillful surveyors  
19 making the measurements on the heave gauges, and they  
20 are making their measurements with the accuracy of  
21 3/1000ths of a foot. We placed these heave gauges so  
22 that we could measure the amount of heave occurring  
23 within the frozen soil. I'd like to show you some of  
24 the results of the heave in the frozen soil around the  
25 pipe section at the Calgary field test facility, if  
26 I could.

27 Q Proceed to do it, please.

28 A This is a figure that  
29 shows the heave gauge locations in the control section.  
30 The other sections are more or less similar, but it



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1 shows along here, for example, horizontal scale  
2 in feet going each way from the centre line of the pipe,  
3 it shows the ground surface, the depth below the ground  
4 surface, it shows our pipe, and the mound or berm over  
5 top of the pipe, and all of these locations are the  
6 locations which we have heave gauges within the  
7 soil.

8  
9 Now as the frost front starts  
10 to move around, after the test starts to grow, after  
11 we started the test. Before I get into that just to  
12 be clear, each one of these heave gauges has a riser  
13 coming up to the surface. We have a deep bench mark  
14 that we installed at the field test-site, and it is  
15 by means of the surveying that we measure the amount  
16 of heave of the gauge down here by measuring the heave  
17 at the surface of the rod.

18  
19 Getting back to my other dis-  
20 cussion, as the frost bulb starts to move around the  
21 frost front, it starts to approach, for example, heave  
22 gauge No. 11. Up until that time, there's no frozen  
23 soil beneath the heave gauge, so there should be no  
24 movement of the heave gauge, there's no heave there.  
25 But as soon as the frost front starts to pass through,  
26 and this is a frost susceptible soil and it's heaving,  
27 then we start to see the heave gauge move up. Now as  
28 the frost front advances down towards 12, we have  
29 plotted the difference, the amount of heave that  
30 has taken place between heave gauge 11 and heave gauge  
31 12. As the frost front moves down here, there's  
32 been a certain amount of heave. Heave gauge No. 11





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1 moves up, No. 12 hasn't moved, and you get a certain  
2 amount of heave. As the frost front comes down to  
3 No. 12, No. 12 also starts to move, and the frost front  
4 then penetrates on down farther.

5 The point that I'm addressing  
6 is what happens to the heave between heave gauge 11 and  
7 12, after the frost front has gone through? In other  
8 words, is there any heave occurring back in the frozen  
9 zone of the soil?

10 Q And if I could interrupt  
11 there, if Dr. Williams' theory is correct, you would  
12 expect to see heave at heave gauge 11 when the frost  
13 front is past heave gauge 12.

14 A That is correct.

15 Q I'm sorry, it's differential  
16 heave that you'd see, a different kind of heave, a  
17 different order of heaving.

18 A Well, no, the way we've  
19 got it, the way we've got it right now is that we're  
20 taking the difference between the heave so we know that  
21 the whole frozen zone, for example, if it's frozen here  
22 we know that it's all moving up and it's all moving  
23 up at the same rate as the pipe, but what we're doing  
24 is taking a separate measurements on No. 11 and No 12  
25 and subtracting those two all the time and seeing  
26 what's the relative movement between those two gauges  
27 with time.

28 Now, I guess to have been  
29 consistent I should have actually had the heave gauge



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1 presentation for 11 and 12, but I don't have those.

2 This happened to be a handy slide to show how the heave  
3 gauges worked; but this is where the deep burial section,  
4 this is the kind of burial depths that we're talking  
5 about and in general greater, so it's more pertinent  
6 to talk, for example, about the deep burial.

7 (VIEW GRAPHS OF DR. SLUSARCHUK MARKED EXHIBIT 282)  
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WITNESS SLUSARCHUK:

Along here we have heave in feet on this axis, okay, and this is the heave line. I will talk to it, in a minute, I just wanted to let you know what it is and that is the heave, or the heave in the soil between the two -- between the two heave gauges.

Okay, it is the actual separation of those two gauges with time.

Now, along here I have temperature plotted and for convenience I have drawn in the 32° isotherm along here. Now, Gauge 19 was higher than Gauge 20 so it was closer to our pipe, it was getting colder faster, so the frost front -- this is the temperature was decreasing and at this point in time the 32° isotherm started to pass through heave gauge number 19. You can see at this point we started to measure some heave at Gauge 19. Gauge 20 was not moving, so this is the heave between the heave of the soil that was taking place between Gauge 19 and 20 with the frost front just part way inbetween the two gauges.

Gauge number 20, the temperature was getting colder and at this point it, too, reached 32° -- reached the freezing point and the frost front moved through that gauge. That is around there. You can see that by in large -- at least within the accuracy of our measurements there is no heave taking place between heave gauges 19 and 20 in the frozen zone after the frost front has penetrated both gauges.





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1 I have got another one,  
2 but it just shows the same thing and we have a lot of  
3 others, so I don't think that I really need to show  
4 another one unless you want to see --

5 Q Well, all the results  
6 then are consistent with what you have just shown?

7 A That is right.

8 Q And if Dr. Williams was  
9 correct, what would you have expected to see?

10 A Well, if Dr. Williams  
11 is correct, I would have expected to see this heave  
12 taking place which is the lensing heave and then  
13 behind that some additional heave in the frozen  
14 soil due to heaving in the frozen soil, so my line  
15 would have then been increasing upwards instead of  
16 being horizontal.

17  
18 Q And that is what he  
19 finds a paradox.

20 A Yes, the results that  
21 I have shown and there are others as I have mentioned,  
22 clearly indicate that over the 18 month period and  
23 within the accuracy of these measurements, no heave  
24 behind the frost front has taken place. This is  
25 entirely consistent with our views on rates of heave  
26 behind the frost front and is not what Dr. Williams  
27 calls a paradox.

28 Q Dr. Slusarchuk, I next  
29 want to turn to another criticism of Dr. Williams as  
30 to our experimental methods. It has to do with the



1 accuracy of measurement of our gauges, our dial  
2 gauges, I think that is in the lab and that appears  
3 at page 10310 to 12 of the transcript, and again to  
4 make sure that I don't misquote him I better read it.

5 THE COMMISSIONER: Excuse me,  
6 before you go on, Mr. Genest, could I just return  
7 to the series of questions -- or the series of answers  
8 Dr. Clark gave at the outset this morning, if you  
9 don't mind --

10 MR. GENEST: Of course, sir.

11 THE COMMISSIONER: You  
12 said that if Dr. Williams was right and the pulling  
13 forces drawing water into the frost bulb were four  
14 or five times as severe as Arctic Gas had estimated  
15 they were, that the frost heave that would result  
16 would be of a magnitude such that no remedial measures  
17 of a practical nature would be possible. You said  
18 that would apply throughout the zone of continuous  
19 permafrost and the zone of discontinuous permafrost.  
20 If you were backed into that corner and I understand  
21 perfectly that you dispute Dr. Williams position root  
22 and branch, just returning to that starting point  
23 for a moment; you said that the proposal to  
24 build a buried chilled gas pipeline would be out  
25 of the question.

26 As I understood it you also  
27 said that running a gas pipeline at above freezing  
28 temperatures would be out of the question because  
29 you would thaw the permafrost and subsidence and  
30 settlement would occur and that there was no way of



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1 building the pipeline practically through permafrost  
2 without chilling the gas.

3  
4 Now, if those two propositions  
5 are sound, then would you -- the only way that you  
6 could build a gas pipeline would be to elevate it,  
7 is that where you would be forced to go?

8 WITNESS CLARK:

9 A That is where we are  
10 at and quite obviously as Dr. Morgenstern pointed  
11 out wouldn't be necessary to elevate it over  
12 its entire length. There are portions of the  
13 continuous permafrost zone that are thought stable  
14 that it could be buried.

15 Q Where you don't have ice-  
16 rich permafrost.

17 A Yes.

18 THE COMMISSIONER: Yes.  
19 Sorry. I just wanted to have the framework in mind.

20 MR. GENFEST: And perhaps  
21 it might also be useful to recall at this stage,  
22 Dr. Clark, Dr. Purcell's concerns about the risks  
23 associated with an elevated gas line?

24 A That is correct.

25 Q What were those if  
26 you could refresh our memory.

27 A Largely they relate to the  
28 metallurgy, the fact that failure would be very  
29 extensive, would in his view, and we support this  
30 view, not only destroy the pipeline, but also the  
supporting mechanism. I believe the analogy that he



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1 gave at the time, at least it is one that we have  
2 used internally, and I think he gave it here, is  
3 that it would be comparable to an unrestrained fire  
4 hose on a failure, and it would fail over great  
5 lengths between stations.

6 Q And that sort of behaves  
7 like an angry snake.

8 A I don't recall  
9 seeing an angry snake.

10 (LAUGHTER)

11 A There are other  
12 factors too, of course: the cost, the fact that the  
13 pipeline has to be insulated, the fact that it is  
14 in our view -- and in the view of our consultants,  
15 a much greater environmental impact.

16 THE COMMISSIONER: Yes,  
17 well, the cost of an elevated pipeline would presumably  
18 be a great deal more than the cost of a buried pipeline.

19 A That is certainly  
20 my understanding and we have had some numbers produced,  
21 I don't recall them exactly, but I would think that  
22 it would be of the order of twice as much, perhaps  
23 more. There are a number of factors that come into  
24 it.

25 Q And that is one reason  
26 why the Alyeska Pipeline, as I understand it, has  
27 cost so much more than it was originally estimated  
28 it would. They have had to elevate it -- at least  
29 they have elevated it, whether they had to or not, over  
30 a much greater length of the route than they





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1 originally thought they would have to when they  
2 estimated it would cost only \$900 million.

3 A Yes, that is also  
4 my understanding.

5 Q And Arctic Gas is  
6 not proposing to build an elevated gas pipeline  
7 along the route of the Mackenzie River and --  
8 let me put it this way, if the proposal to build  
9 a buried gas pipeline were one that had to be  
10 abandoned, then there would be no pipeline project  
11 for any tribunal to consider, is that where we  
12 would be?

13 A I don't know that  
14 for sure. I don't know what the policy or position  
15 of Arctic Gas would be if they were for some  
16 reason forced to go to an elevated pipeline.

17 MR. GENEST: I suppose it  
18 would have something to do with the price of gas,  
19 how much we could sell the gas for in the south, that  
20 effects the total economics of the --

21 THE COMMISSIONER: I am  
22 sure. You might need --

23 MR. GENEST: If you could  
24 sell gas for \$100.00 a thousand cubic feet it  
25 might be economical.

26 THE COMMISSIONER: Well, at  
27 the very least you might have to ask for an  
28 adjournment.

29 MR. GENEST: I would ask for  
30 an adjournment, that is right.



1 I was directing -- Sir, is  
2 that --

3 THE COMMISSIONER: That  
4 is fine.

5 MR. GENEST: Can I proceed?  
6 I was going to direct your attention to a criticism  
7 about the accuracy of measurement which I think  
8 to understand it all we have to start at the bottom  
9 of page 1310 where at about line 25 -- I am sorry,  
10 10310. 10310, line 25 where Dr. William says in  
11 answer to the question:

12 "I have a criticism of the methodology"  
13 The question:

14 "Well, perhaps you could --"

15 Answer:

16 "Yes. Well, I stand to be corrected on  
17 this, but as I understand it, the shut-  
18 off pressures were applied to the  
19 top, I presume, of the sample in  
20 order to stop the entry of water  
21 into the bottom of the sample. The  
22 thing might have been the other  
23 way up, I don't know, but the idea  
24 was to apply enough pressure to stop  
25 the entry of water into the sample  
26 but I don't think that the actual  
27 heave taking place was being measured  
28 with a great deal of accuracy at the  
29 same time.

30 The primary interest was whether



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1 the water stopped going in or out  
2 or not. The fact that the water  
3 stopped going in didn't mean that  
4 the pressure being developed, and  
5 which was being counteracted, was in  
6 fact totally counteracted and the  
7 volume may have been well increasing  
8 by a very small amount."





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1 Q "Well, if I understand your first criticism,  
2 if you like, the methodology is that you  
3 are not satisfied that the heave was being  
4 accurately measured. I'm instructed that it  
5 was being measured to within 1/1000ths of an  
6 inch.

7 A M-hm, well I mean that may be. We have dial  
8 gauges that claim that sort of thing, but if  
9 I could --

10 Q Well now, just let me concentrate on that point,  
11 sir. Now are you dealing with something that  
12 you know about or something that you suspect  
13 about, or something that is just a possibility?

14 A Yes.

15 Q You have made a criticism, and I am not  
16 suggesting that you have made it without  
17 giving it great thought, but I just want to  
18 know what the basis of the criticism is?

19 A Yes. Well, 1/1000ths of an inch sounds very  
20 impressive, and I presume that the accuracy  
21 of the heave measuring system was plus or  
22 minus 1/1000ths of an inch; and that was in  
23 a period of a few days, I don't know how long  
24 a period involved was, but to make a simple  
25 example, supposing it was one day and we could  
26 in fact have been having --"

27 And then there is an interjection where Dr. Williams  
28 is asked to continue.

29 "The gauge was capable of measuring any heave  
that was greater than 1/1000ths of an inch but



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1 it wasn't capable of measuring less than 1/1000th  
2 of an inch. That's what we understand by measuring  
3 something with an accuracy of 1/1000th of an  
4 inch.

5 Now if the experiment lasted  
6 one day we could in fact have had a heave that  
7 was not 1/1000ths of an inch, but point 9 of  
8 1/1000th, and we wouldn't have known anything  
9 about it. We wouldn't have known anything about  
10 it. In a thousand days we would have had nearly  
11 an inch of heave and you wouldn't have known  
12 about it."

13 I'd like to ask you your  
14 comments on that criticism, Dr. Slusarchuk.

15 A Yes. Well, just to be  
16 absolutely clear, the lateral slide presentation that  
17 I gave <sup>was</sup> with regard to measurement of heave at the  
18 Calgary field test-site, and this criticism is now  
19 directed towards the measurement of heave in our  
20 4-inch test samples in the laboratory. I believe we  
21 told Dr. Williams that we were measuring this heave  
22 to an accuracy of 1/1000ths of an inch, when in fact  
23 we are only measuring this heave to an accuracy of  
24 3/1000ths of an inch. That's three times poorer.

25 THE COMMISSIONER: Yes, that's  
26 the margin that you can't measure.

27 A Yes.

28 MR. GENEST: The suggestion  
29 by Mr. Marshall of 1/1000ths was erroneous, it was  
30 3/1000ths.



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A It was 3/1000ths, yes.

However --

THE COMMISSIONER: That's only  
a 300% error.

A However, since we've run  
our tests for three days, and Dr. Williams in his  
evidence was using the value of 1/1000ths of an inch  
per day, an error of 1/1000ths of an inch per day in  
his example, it appears that this information would  
not change his argument at all.

Dr. Williams says that if we  
missed by 1/1000ths of an inch per day, then for  
example over 20 years this means that we potentially  
miss about seven inches of heave. However, I believe  
the more appropriate method to estimate our potential  
error over 20 years would be as follows: We freeze  
at least two inches of soil during our test, and during  
this time we missed heave in this two inches of frozen  
soil by 3/1000ths of an inch. For a frost bulb that  
develops to a depth of 30 feet below the pipe, this  
would mean that we could potentially miss about a half  
an inch of heave. In other words, in two inches of  
freezing soil, we would miss heave by 3/1000ths, and  
if you multiply that two inches to get you -- divide  
that two inches into 30 feet to get your multiplier  
factor, and multiply that by your error, because we're  
making an error of 3 thou in two inches, it comes out  
to a half an inch. I'm saying that's a more appropriate  
way of looking at the error in our dial gauges than  
assuming that we're going to have an error of 1/1000ths



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1 every day as the test goes along or time, the length of  
2 the pipeline, duration of the pipeline.

3 With regard to the one-half  
4 inch now, this amount of heave is of absolutely no  
5 significance to us.

6 Q Thank you, Dr. Slusarchuk.  
7 I'd like to turn to Dr Harlan now, and to the subject  
8 of Dr. Williams' statements that there are other  
9 approaches to predicting frost heave, and to put that  
10 in context. I'll have to read, Mr. Commissioner, about  
11 three pages of Dr. Williams' evidence. They start at  
12 page 10304 and go to page 10307. At page 10304,  
13 line 6, the question, cross-examination by Mr. Marshall  
14 again:

15 "Q Do you know of any other way to predict frost heave,  
16 a way different from that proposed by the advisors  
17 to Arctic Gas?

18 A Well, there's a variety of ways that are used  
19 both in practice and have been suggested exper-  
20 imentally. Of course, the highway engineers  
21 habitually measure the grain size composition of  
22 the soil, it is a method that is not really  
23 defensible theoretically but it works roughly  
24 for the highway people.

25 Q For highways. You wouldn't suggest it for  
26 pipelines?

27 A Well, I mean you mustn't throw out these  
28 elementary approaches because in practice  
29 you often can't do anything more sophisticated  
30 but it can never be an exact test, the grain





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1 size composition procedure. People have tried  
2 other tests based on --

3 Q Excuse me, this is really frost susceptibility  
4 criteria that you're talking about here, rather  
5 than frost heave?

6 A Yes, I thought that's what you meant.

7 Q No, I meant really predicting frost heave.

8 A The actual quantitative amount of heave?

9 Q Yes.

10 A Do I know an alternative test?

11 Q Yes. In an alternative technique.

12 A Yes, there is the strictly theoretical approach  
13 in which you take a number of input parameters,  
14 which you determine individually, they're very  
15 numerous and Dr. Harlan, of course, knows all  
16 about this -- and I mean that approach is, I  
17 think, excellent.

18 Q That doesn't help me very much because it just  
19 tells me it's a theoretical approach involving  
20 a number of input parameters and where does that  
21 take me?

22 A I can tell you where it doesn't take us. The  
23 weakness lies in the accuracy of the input parameters  
24 that we have to determine.

25 Q And having something to test them against?

26 A Not test them against exactly, but if you have  
27 one of the input parameters, the thermal conduct-  
28 ivity of the soil, and the question at once  
29 becomes how good, how good determinations can we  
30 make of thermal conductivity of soil?



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1 Q Does that exhaust your list of alternative approa-  
2 ches?

3 A Well, I mean, I have said there's a theoretical  
4 way and there's an experimental way. The pro-  
5 cedure here, of course, is the experimental.

6 Q Have you --

7 A I would say exclusively almost.

8 Q Sir, you mentioned the theoretical approach as  
9 contrasted with an experimental approach, and  
10 I was wondering whether you have in an actual  
11 engineering situation employed such a theoretical  
12 approach?

13 A No, I don't believe anybody has attempted to  
14 provide engineering solutions using a theoret-  
15 ical approach full out. I mean, one uses  
16 engineering judgment and all that sort of thing.

17 Q So you wouldn't then be able to, by reference to  
18 a specific concrete example, field example, I  
19 suppose, be able to tell us about methodology  
20 or the exact situation. None to your knowledge  
21 exists.

22 A You mean --

23 Q On the point being theoretical.

24 A Could I tell you or refer you to somebody who  
25 would do it for you?

26 Q No, who has done it, sir?

27 A No, no.

28 Q Well, if you were faced with the challenge of  
29 predicting frost heave for a chilled pipeline,  
30 which approach would you tend towards?



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1 A If I was asked to predict quantitatively  
2 the amount of heave for a chilled pipeline,  
3 I'm afraid I would decline the job."

4 And that's the end of the quotation.

5 Now, Dr. Harlan, back at page  
6 10305 there is a mention of a theoretical approach  
7 with which you are alleged to know all about. Can you  
8 comment about the theoretical approach to the prediction  
9 of frost heave?

10 WITNESS HARLAN:

11 A Yes.

12 Q Generally on that  
13 passage from Dr. Williams' evidence.

14 A I would summarize it  
15 this way, I would simply state that to the best of my  
16 knowledge a theoretical approach for predicting frost  
17 heave under various soil, temperature and moisture  
18 conditions has not been developed. Further, there is  
19 not general agreement on an acceptable theoretical  
20 approach.

21 Q And are some of the  
22 difficulties outlined by Dr. Williams himself in that  
23 passage I read?

24 A Yes.

25 Q The difficulty of  
26 defining the parameters.

27 A That is correct.

28 THE COMMISSIONER: You are  
29 at one with Dr. Williams there then, I take it.  
30 That is that there isn't --

A No, I think we're just





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1 opposite.

2 Q Oh, he thought that your  
3 approach was O.K., but you say --

4 A Well, that's quite a  
5 compliment.

6 Q Yes, and one that no one  
7 else in the field is prepared to pay you.

8 A That's right.  
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MR. GENEST:  
yes, it is a little

difficult, I don't know what Dr. Williams means there.  
At 13305 he calls it an excellent approach, but  
then he --

THE COMMISSIONER: He says  
the difficulty is determining the parameters or  
agreeing upon them and I suppose that is where it  
breaks down.

A Yes, that is correct.

MR. GENEST:

Q Dr. Slusarchuk, have  
you in your research encountered any method other  
than the one that you have developed that has been  
evolved to predict frost heave?

WITNESS SLUSARCHUK:

A No, sir, no, sir,  
I haven't. I have talked with many people involved  
in frost heaving and without exception they have  
informed me that they are not aware of any method  
other than the one that we have developed to predict  
the amount of heave for our chilled buried pipeline.

THE COMMISSIONER: Well,  
Dr. Slusarchuk, let me ask you this, are you --  
you developed this method to predict frost heave --

A Well, we at N.E.S. at  
any rate, yes.

Q All right. By "you" I  
mean the whole Arctic Gas, N.E.S. group.

A Yes, sir.

Q Now, you have developed



1 this method for predicting frost heave. Are you  
2 pioneering or do you say that that is a method that  
3 others have used successfully in the past?

4 A Well, it may be  
5 pioneering in one sense, but the basic fact that  
6 overburden pressure, and nominal amounts of overburden  
7 pressure, would dramatically reduce the rate of  
8 heave has been known for years. We have searched the  
9 literature and we have got evidence, it goes back  
10 to Besco in 1930. We had two of our people that I  
11 have referred to, McRoberts and Nixon have searched  
12 the literature for that. They have found evidence  
13 as far back, as I say, Besco, there was work by  
14 Lenel and Kappler from Cold Regions Research that  
15 suggest the same thing. Aikin did some very nice  
16 tests up in Alaska where he actually loaded large  
17 areas with different weights and just naturally let  
18 it freeze and saw that they heaved at different  
19 rates. We have looked at Russian literature and  
20 we have picked out of there the very same thing and  
21 the concept to me, sir, is not unique, it is not  
22 particularly novel and it is certainly not pioneering.

23 In my view, the one reason  
24 that people have not really taken advantage or  
25 made use of this sort of approach is because they  
26 have never had a situation that is really amenable  
27 or that really helped them a lot. They are always  
28 building highways or airfields where the loads were  
29 low. They were dealing with skating rinks or freezers  
30 where they couldn't withstand much differential heave.



1 We are talking about a pipeline that can stand a  
2 fair amount of differential heave.

3 We are talking about a pipeline that we can put  
4 a fair load on the frost front and when you combine  
5 those two factors it gives the ideal situation to  
6 take advantage of what has been known in the literature  
7 for years.

8 WITNESS MORGENSTERN:

9 A There is, I think a  
10 pioneering element. While the principles as Dr.  
11 Slusarchuk stresses are well established, well recog-  
12 nized, the pioneering component is the systematic  
13 integration of the frost heave tests that we undertake  
14 to predict heave with time. That is a pioneeing  
15 element.

16 THE COMMISSIONER: No on e  
17 regards this as something personal, Dr. Slusarchuk,  
18 you know, we are here to challenge the things that  
19 you people put forward to see if they do stand up  
20 to scrutiny. There are sometimes limits to what  
21 technology can do. A famous architect in Boston  
22 designed a tall building recently that he must have  
23 done something wrong because the windows keep blowing  
24 out and it is boarded up now, but --

25 WITNESS SLUSARCHUK:

26 A Well, I apologize  
27 if I make it sound like I am taking it personally,  
28 but --

29 THE COMMISSIONER: No, you  
30 are entitled to get quite heated --





1 MR. GENEST: Chilled is the  
2 word, sir.

3 A My honest view is that  
4 the basic material is not pioneering . Now, Dr.  
5 Morgenstern feels it is a little more pioneering than  
6 I do. That is his view.

7 Q I would like to move  
8 to the subject of differential heave that Dr. Williams  
9 spoke about, and again if I can quote from his  
10 testimony at page 10252, which was near the beginning  
11 of the volume. At the top of the page the question, --  
12 that was his examination in chief.

13 Question:

14 "Dr. Williams, you have briefly mentioned  
15 situations where large differential  
16 heaves may occur. I wonder if you could  
17 elaborate on the matter, particularly with  
18 reference to the potential pipe deformation  
19 in excess of the limits of permissible  
20 curvature laid down by Canadian Arctic  
21 Gas. What kinds of situations have the  
22 highest potential for differential  
23 heave?"

24 Answer:

25 "Well, firstly, I think that one should  
26 be aware that the two and a half feet  
27 in 100 feet permissible curvature of  
28 the pipe can be misleading. I don't  
29 think any of the specialists involved  
30 really think that there will be a



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1 uniform, smooth, slight curvature of  
2 the pipe over the 100 foot lengths.  
3 Rather we are concerned with inflections  
4 over relatively short distances and if  
5 one instead talks of three inches in  
6 ten feet, one realizes that the guidelines  
7 are quite demanding. Now, an example  
8 of a particularly bad situation would,  
9 I believe, be where the pipe rests on  
10 bedrock or perhaps coarse gravels, that  
11 is something that is not very susceptible  
12 to heave at all, and then moves into  
13 very susceptible material so that one  
14 might have a transition from rock  
15 and proceeding further into, say,  
16 fine, silty material. Now there will  
17 be no heave where the pipe lies on the  
18 rock and to ensure that in the first  
19 ten feet in the silty area there not  
20 be three inches of heave, that is  
21 very difficult. Most people experienced  
22 in frost heave certainly wouldn't  
23 regard the three inch heave as large  
24 and yet this heave must, to meet the  
25 guidelines be prevented by some means,  
26 presumably in the eyes of Northern  
27 Engineering Services by application  
28 of shut-off pressures. To keep  
29 differential heave down to three  
30 inches in ten feet, at points of



1 transition between heave prone  
2 material and those not prone to  
3 heave at all, is a very demanding  
4 requirement."

5 Could you comment on that, please, Dr. Slusarchuk?

6 A Yes. From this I  
7 understand Dr. Williams to be saying that it is  
8 difficult to predict heaves in soil alone to an  
9 accuracy of three inches over a length of ten  
10 feet and he implies that the pipe will be over  
11 strained in many cases because of it.

12 As an example of a  
13 particularly bad situation, Dr. Williams cites the  
14 case where the pipe goes from bedrock or a non-  
15 heaving zone abruptly into a heaving zone and states  
16 in effect that to ensure that in the first ten  
17 feet in the silt area there not be three inches of  
18 heave would be certainly difficult.

19 A statement such as that  
20 is quite misleading because it assumes that our  
21 pipe will not lift off its bedrock base, as indeed  
22 our calculations have shown that it will, because  
23 the pipe is very stiff over lengths of ten feet.  
24 The actual allowable differential heave for a given  
25 length of heaving pipe can only be calculated from  
26 a detailed pipe soil interaction analysis. Northern  
27 Engineering has developed procedures for undertaking  
28 these analyses and they will be applied to conditions  
29 along the right-of-way.

30 Q In other words, let's





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1 see if I understand that, if you have got a pipe which  
2 is dug in a trench and it is filled -- if it is in  
3 bedrock -- it is filled with backfill and it is  
4 coming out of the bedrock which is not frost  
5 susceptible into a very soft frost susceptible soil,  
6 that is where you get your point of differential  
7 heaving so the frost susceptible soil will lift the  
8 pipe at that point, but what you are saying is  
9 that the pipe, thus all the stresses won't be  
10 applied there, the pipe will lift along the bedrock ,  
11 along the trench in the bedrock.

12 A Yes, it does.

13 Q So do you agree then  
14 that these are very demanding requirements that N.E.S.  
15 has laid down?

16 A Well, I think the  
17 requirements are demanding in some respects, but not  
18 to the degree that Dr. Williams is implying here. We  
19 have established the criterion of differential heave  
20 along the pipe and it allows us to have fairly sub-  
21 stantial heat. I think I said before something like  
22 two and a half to four feet over lengths of 100 to  
23 150 feet, so in my view it is still a reasonably  
24 demanding criterion, but not an unacceptably demanding  
25 criteria.

26 Q Thank you. Dr.  
27 Morgenstern, if I may turn to you now, sir.

28 I want to invite your  
29 comments on --

30 THE COMMISSIONER: Well,



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1 maybe we could stop for coffee.

2 Excuse me, how are we coming  
3 along?

4 MR. GENEST: Sir, I think  
5 I have another half hour.

6 THE COMMISSIONER: Oh, fine.  
7 And then you propose to adjourn until tomorrow?

8 MR. SCOTT: I think that  
9 is the plan, sir.

10 THE COMMISSIONER: And who  
11 are we hearing tomorrow then?

12 MR. GENEST: Sir, I am prepared  
13 to go ahead with Mr. Williams' rebuttal evidence of  
14 what we have heard to date.

15 THE COMMISSIONER: On  
16 construction.

17 MR. GENEST: On construction,  
18 reserving my right to rebutt later what Dr. Adam has to  
19 say on that subject. I understand from Mr. Templeton  
20 that they would rather not go ahead with Dr. Adam's  
21 cross-examination tomorrow.

22 THE COMMISSIONER: Fine, well  
23 then that would complete the evidence this week. Then  
24 what is the program for -- we wouldn't sit Saturday  
25 then?

26 MR. GOUDGE: That is correct,  
27 sir, and we would begin next week with the witnesses  
28 from Alaska who are arriving Monday morning and will  
29 be available for the usual one o'clock starting time  
30 on Monday and they will be followed by Dr. Hughes



1 who will reappear for cross-examination and following  
2 that Mr. Anthony has two witnesses to appear for  
3 examination in chief and cross-examination and I think  
4 that all the parties have summaries of their evidence  
5 and following that we would hope to hear the  
6 Arctic Gas evidence in chief delivered by a spokesman  
7 or two on their first phase II, III panel.  
8 I think that is a full week's work, sir.

9 THE COMMISSIONER: Who are  
10 the witnesses from Alaska Monday?

11 MR. GOUDGE: Dr. Weedon and  
12 Mr. Parker -- or Mr. Weedon and Dr. Parker -- I can't  
13 remember which it is.

14 THE COMMISSIONER: Commissioner  
15 Parker and Dr. Weedon.

16 MR. GOUDGE: Yes, sir.

17 THE COMMISSIONER: All right.

18 MR. GENEST: And perhaps  
19 I can discuss with my friends when this panel will  
20 return for cross-examination.

21 THE COMMISSIONER: Well, when  
22 this panel returns for cross-examination, you might  
23 consider and I leave it is entirely up to you, Mr.  
24 Scott, and you, Mr. Goudge, that you might consider  
25 bringing Dr. Williams back when you cross-examine. You  
26 might consider as well getting in touch with Dr.  
27 Miller of Cornell and Mr. Penner of the N.E. --  
28  
29  
30



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MR. SCOTT: Before we add  
to the witnesses, Mr. Commissioner,  
I should tell you that Mr. Williston, who is giving  
evidence for El Paso in Washington next week on the  
administrative procedures in Canada, phoned me to ask  
how long we were taking, and I said we were moving  
along very quickly and would be through very soon.

(LAUGHTER)

THE COMMISSIONER: Well, can I  
have that in writing?

Well, let's adjourn for coffee  
then.

(PROCEEDINGS ADJOURNED FOR FEW MINUTES)

(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

THE COMMISSIONER: Well, I've  
had my tea so we can start again.

MR. GENEST: Q Dr. Morgenstern  
at the break I was directing your attention to some  
criticisms of Dr. Williams, they were sort of general,  
about the approach that has been used by Arctic Gas or  
by N.E.S. in its handling or its approach to the  
frost heave problem. Perhaps without reading at  
length from the transcript, I could summarize, and the  
transcript references are page 10250, 10378, 10329,  
and in general Dr. Williams has criticized Northern  
Engineering for taking<sup>a</sup> somewhat narrow and strictly  
imperical views of the problem. He has criticized  
us for not having paid more regard to theoretical  
knowledge, and he has criticized -- well, he's repeated  
again his criticism that we've gone at the whole matter  
in an imperical fashion. Do you have any comments





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1 on that critique?

2 WITNESS MORGENSTERN: Yes.

3 The presentation of our position today indicated that  
4 we have consulted widely, and I hope demonstrated that  
5 we're well aware of the various theoretical develop-  
6 ments related to frost heave. I can't accept the  
7 criticism that our view has been narrow, and moreover  
8 I wouldn't apologize for our imperical developments,  
9 particularly when they provide an engineering solution  
10 to a difficult problem.

11 We all agree that the funda-  
12 mental processes going on in freezing soils are  
13 complex, and when one approaches them from a thermo-  
14 dynamic point of view, or from a mechanical point of  
15 view, there has been no theoretical procedure developed  
16 capable of predicting the amount and rate of heave,  
17 encountered by this pipeline other than the one we  
18 advocate. It's often not possible to find a solution  
19 to an engineering problem other than in an imperical  
20 manner. I think this is particularly so when we  
21 deal with natural materials and natural processes.  
22 The methodology, procedure, conceptual framework that  
23 we've adopted here is fairly typical of much engineering  
24 research and development. Northern Engineering and  
25 Arctic Gas adopted a test, this was a frost heave test  
26 undertaken in a laboratory, that is felt to be  
27 characteristic of the total system of freezing, of  
28 the soil close to the conditions that it will  
29 experience in the ground when the pipeline is in  
30 operation. The configuration of the test has been



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1 assembled in a fairly conservative manner to ensure  
2 that abundant water is available, and so on. Various  
3 sensitivity studies that probed into how the results  
4 of the tests are sensitive to one thing or the other  
5 have been undertaken so that one can explore how  
6 reliable are the results of these tests, depending  
7 upon the conditions that are controlled.

8 From the testing and the  
9 analysis, or the inspection, the scrutiny of this test  
10 of the frost heaving system, we conclude that the  
11 relationship between heave rate and pressure is a  
12 legitimate characteristic of that system that is being  
13 embraced by the tests, and all of the complicated  
14 processes of pulling forces and the water migration and  
15 things like that that are certainly a matter of ongoing  
16 fundamental reserach, are occurring within the test.  
17 The key simplification that we arrive at is that for  
18 all practical purposes under the conditions that the  
19 pipeline will encounter, heave rate is primarily a  
20 function of the applied pressure. Ultimately the  
21 shutoff pressure suppresses it and as we know, if it is  
22 less than shytoff pressure you get some heave rate.

23 Utilizing this result, this  
24 test, this characteristic of the freezing system,  
25 we've developed a method of calculating heave with time  
26 as the frost bulb advances and Dr. Slusarchuk illustrated  
27 some o f the predictions. All of that work has been  
28 a systematic development, and for a key problem such  
29 as this we would have been quite remiss if we hadn't  
30 checked our procedures under prototype conditions.



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1 This has been done with great  
2 care at the Calgary test facility, and again Dr. Slusar-  
3 chuk has brought us up to date on the results of that  
4 set of experiments, under field conditions prototype  
5 scale.

6 I'd like to stress once again  
7 that the duration of this testing is now 18 months,  
8 I'm certainly comfortable in feeling that that duration  
9 of testing is representative of the duration of the  
10 lifetime of the pipeline, that the trends that have been  
11 established, the things we've learned, are characteristic  
12 of what will go on for just say, another factor of 10,  
13 longer time.

14 Moreover, we're comforted  
15 by the conservative nature of the comparison between  
16 our imperical theory and the behaviour of the test  
17 facility. I'd like to emphasize that again. Our pre-  
18 dictions at this time are all on the safe side. We  
19 feel that they give us acceptable engineering solutions  
20 but also on the conservative side. We hope to find  
21 cue lists(?) over the next while to make  
22 them perhaps slightly less conservative point in the  
23 economy. This-- whether this will be achieved or  
24 not remains to be seen.

25 So this imperical approach  
26 provides an acceptable engineering solution to a  
27 difficult problem. I am proud of the impericism and  
28 am in no way ashamed of it. I'd like to stress that  
29 it doesn't ignore current theoretical concepts but  
30 rather recognizes their limitations in providing practical





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1 solutions. I'm stressing perhaps a slightly different  
2 emphasis of engineering research and development as  
3 opposed to fundamental scientific work.

4 Q Thank you, sir.

5 Dr. Clark, can you summarize  
6 for us the position really of your panel, of N.E.S.  
7 with reference to the evidence of Dr. Williams, and his  
8 thesis, and the effect of our work on frost heave?

9 WITNESS CLARK: Yes. Well, the  
10 purpose of this rebuttal evidence has been to deal  
11 with specific points raised by Dr. Williams regarding  
12 the experimental work and computations carried out by  
13 Northern Engineering Services in regard to frost  
14 heaving. Now the purpose of Dr. Hoekstra's and Dr.  
15 Harlan's rebuttal evidence was to illustrate that the  
16 thermodynamic relations used by Dr. Williams are not  
17 intended for that purpose, and are not in keeping with  
18 the vast amount of scientific information available  
19 in the literature.

20 Dr. Williams claims that N.E.S.  
21 has neglected the theoretical and experimental work  
22 available in the literature, and this is a rather  
23 surprising statement, from Dr. Williams, since the  
24 literature that he refers to in his direct evidence  
25 is predominantly that generated by Harlan, Hoekstra  
26 and Miller. Dr. Williams is aware the Harlan and  
27 Hoekstra both work for Northern Engineering Services,  
28 and he's also aware that they are equally as familiar  
29 with the vast body of scientific literature as Dr.  
30 Williams himself is.



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1 In addition, Dr. Slusarchuk  
2 mentioned many other researchers with whom we have  
3 discussed frost heaving. Implicit in Dr. Williams'  
4 evidence is that heave is much greater than that calcula-  
5 ted by N.E.S. In fact, the opposite is true. As  
6 shown by Dr. Slusarchuk, the method developed by N.E.S.  
7 over-predicts heave. The major effort which N.E.S. will  
8 be conducting on frost heave between now and the start  
9 of construction will be to refine the predicted model  
10 so that the designs are not overly conservative.

11 Dr. Williams refers to a  
12 theoretical model which can be used to predict heave.  
13 When posed with the question to whether or not he  
14 has ever attempted to predict heave, he responded that  
15 he had not, and also indicated that if asked to do so  
16 that he would decline.

17 Dr. Williams has in fact  
18 made a prediction in his testimony. That is that it  
19 will be greater than what we of N.E.S. have predicted.  
20 There is no theoretical or experimental data available  
21 in the literature to support Dr. Williams' view.

22 In our opinion, the vast  
23 majority of the theoretical and experimental work  
24 carried out on frost heaving supports the N.E.S.  
25 approach.

26 To our knowledge, the method  
27 that has been developed by N.E.S. to predict the rate  
28 and amount of heave is the only model that is available  
29 to carry out such computations. The experimental  
30 work has been carried out both in the laboratory



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1 and in the field; the results from the short term  
2 tests which Dr. Williams criticizes, are supported  
3 by both laboratory and field tests which have been  
4 carried out over periods of time, 4,000 times longer  
5 than the short term test. The results over this very  
6 wide time scale are consistent.

7 The main thrust of Dr. Williams'  
8 testimony appears to deal with the very high pressures  
9 that can be developed when soil freezes. He appears to  
10 have completely ignored the effect of heave movement  
11 in reducing these pressures. We have never taken the  
12 position that heave is going to be stopped completely  
13 Our position is that it can be kept within tolerable  
14 limits, and those limits are known. Design measures  
15 to inhibit frost heave that have been proposed have  
16 actually been field tested as illustrated by Dr.  
17 Slusarchuk. They clearly indicate that frost heave  
18 can be controlled. Neither the cost nor the environmental  
19 impact is prohibitive.

20 Dr. Williams' contention that  
21 N.E.S. has ignored the action going on behind the  
22 freezing boundary, that the growth of ice lenses in  
23 frozen soil, is not correct. This has not been ignored,  
24 but it's been assessed in detail and found to be so  
25 small so as to be of little consequence.

26 The shutoff pressure that N.E.S.  
27 deals with is that pressure which will prevent water  
28 from entering the frozen soil and forming ice lenses  
29 in the region of the freezing front. This is the major  
30 component of frost heave, with which we are concerned,



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1 and it's the one that is in an engineering sense, it  
2 must be dealt with. The action behind the freezing  
3 front is of considerable scientific interest, but has  
4 very little engineering application.

5  
6 Finally, I'd like to say that  
7 I believe that the frost heave program that we have  
8 put together have resulted in us being able to reasonably  
9 predict the heave of the pipeline.

10 Q Thank you, and perhaps  
11 in conclusion I can ask you, Dr. Clark, and also Dr.  
12 Morgenstern, whether or not the evidence of Dr.  
13 Williams has raised any doubts in your minds as to  
14 whether we can construct a buried chilled pipeline  
15 and adequately control the frost heave problem?

16 A There's no doubt in my  
17 mind, the pipeline as presently conceived can be built  
18 and can be operated safely.

19 WITNESS MORGENSTERN: I concur  
20 with Dr. Clark.

21 MR. GENEST: Q I'd like to  
22 move very briefly, sir, to -- Mr. Commissioner, that  
23 concludes, I may say, our rebuttal evidence to Dr.  
24 Williams' testimony. I have some, two questions in  
25 rebuttal to the Foothills' testimony related, mainly  
26 it is concerned with Mr. Claridge's testimony on  
27 slope stability.

28 Dr. Morgenstern, perhaps  
29 again without reading long excerpts from transcripts,  
30 the references are at page 9438, 9450, 9589, 9590, in





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1 those parts of his testimony Mr. Claridge, on behalf  
2 of Foothills, has challenged the usefulness of the  
3 thaw consolidation theory in practice. That's our  
4 old friend, C sub V again, for evaluating slope  
5 stability, and he has criticized some of our field  
6 measurements of pore pressures stating that we have  
7 arrived at mistaken conclusions, using dubious testing.

8 Can you comment on this  
9 criticism?

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WITNESS MORGENSTERN:

A In my view this testimony

is in itself misleading and in order to correct the record I would like to describe briefly what the theory of thaw consolidation does, what observational support we have for it and what is its role in practice. Unfortunately as Mr. Genest indicated we must return to our friend C sub V.

I will do that in a moment.

Before that I want to remind you, sir, if I may, that the important origin of strength of soils resides in friction. Soils are frictional materials and hence their strength depends upon the load or stress that is carried by the particles, transmitted between particles in the soil.

If for a given applied loading, loads placed on the soil, more of the load is carried by the water in the soil then less load will be carried by the particles and hence the soil will be weaker. On the other hand, if we get rid of the load carried by the water or the water pressure, we increase the load of the particles because they are frictional in their interaction, then the soil becomes stronger.

So in order to evaluate the strength of the soil we wish to find out how much load is carried by the water and how much by the soil. This is something that is of concern to us, and unfrozen soil mechanics is of concern to us when we inspect the behaviour of permafrost subjected to



1 thaw.

2 If I could show a little  
3 figure to put into context how the theory of thaw  
4 consolidation relates to what I am talking about.

5 The figure on the left is  
6 illustrative of the platform or piston that is carrying  
7 a load and is supported by two springs. I put  
8 this forward to illustrate how load is carried in a  
9 mechanical system depending upon the relative stiffness  
10 of the supports. If we put a load on this system  
11 and this is a soft spring in that it has to deform  
12 a great deal to develop any load carrying capacity;  
13 whereas this is a stiff spring, it deforms very little  
14 to get to a substantial load carrying capacity, then  
15 most of the load will be carried by the stiff spring  
16 and little load will get into the soft spring.

17 Now, the relationship between  
18 that and a soil, a thawed soil, is here, that the  
19 presence of water in the thawed soil, because its a  
20 rather low compressibility behaves like the stiff  
21 spring, so if you put a load on this piston, the  
22 spring here represents the soil skeleton, the analogue  
23 of the reality to the analogous stiff spring here is  
24 the water and load will be carried at the outset by  
25 the water, and little load will be carried by the  
26 skeleton.

27 As the load --

28 THE COMMISSIONER: Excuse me,  
29 oh, yes, by the skeleton.

30 A Yes, this spring --





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1 MR. GENEST: That is the  
2 soil without water.

3 THE COMMISSIONER: Yes.  
4 Thank you.

5 MR. GENEST: Well, thank you.

6 A Thank you both.

7 The soils are you know are  
8 porous materials, they are permeable, they have a  
9 high hydraulic conductivity or permeability as we  
10 sometimes call it and this little hole in the piston  
11 reflects, illustrates mechanically the role of  
12 permeability. If there is a high pressure in the  
13 water, then water will squeeze out of the hole, the  
14 load will be transfered from the water on to the  
15 spring, the soil will compact or consolidate and  
16 it will accordingly become stronger. The strength  
17 then depends upon the relative portion of load  
18 carried by the water and the spring and this is a  
19 dynamic process governed by the propensity of water  
20 under pressure to drain out of the porous material.

21 This process of drainage  
22 and transfer of stress within the system is governed  
23 or described in terms of the parameter  $C$  sub  $V$   
24 which algebraically is the ratio of the permeability  
25 to essentially that spring stiffness. So the  
26 thrust of our research on thaw consolidation over the  
27 past few years has been to find out how the process  
28 of load transfer in a thawing soil occurs. We know  
29 a great deal about normal soils and the mechanics of  
30 these for instance, are well defined. In the thawing soil



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1 the load is put in the soil as thawing occurs and  
2 this transfer of water pressure and stress in the  
3 soil results, and the theory of thaw consolidation  
4 quantitatively tells us what happened.  
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Now, over the

past few years we have developed the equations, that govern this process of thaw consolidation for a variety of configurations that we meet in practice, equations that have been derived and they've been solved and put into useful form, and we have developed laboratory equipment to seek confirmation of the theory and to take measurements and to see whether we observe what was predicted, and we find excellent agreement. So that as a result of that activity we have developed considerable understanding into the process of pore pressure generation employing soils, and we've applied this to several design problems. One context in which we're talking is the analysis of slope stability, because clearly the strength of the soil is a function of how much water pressure is in it, and that's been one of our applications.

We've also applied it to a consideration of the design of a buried warm pipeline, and the process of settlement and differential settlement to be governed by the water migration out of thawing soil, that's another application.

We have applied it as well to the problem of the design of a dam on permafrost when you impound a reservoir of warm water on permafrost you generate thawing, the foundations might become weak because of these processes we're describing. One is interested to know whether the dam would be stable or not. These are some of the applications of the theory.



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1 We have obtained excellent  
2 field evidence in support of the theory from studies  
3 that we analyzed, our studies of the results of the  
4 observations of pore pressures developed at the Inuvik  
5 test loop, which is the test loop undertaken by  
6 Mackenzie Valley Research, the oil pipeline people, some  
7 years ago. They instrumented in this buried warm  
8 pipeline and measured the pore pressures generated  
9 during thaw. We've interpreted this, utilizing the  
10 theory, that I am reviewing so briefly, and find that excel-  
11 lent agreement has been obtained so that there is this  
12 good field support for the theory.

13 Now with respect to slope  
14 stability, this provides us with a conceptual framework  
15 wherein we can evaluate the relative effects on  
16 stability of altering the thermal regime, changing the  
17 rate of thaw, the influence of ground ice characteristics,  
18 the influence of different soil properties, such  
19 as the strength of the soil, co-efficient consolidation  
20 of C sub V. That, then, is the result that we get when  
21 we apply this to slope stability mechanics.

22 The theory of thaw consolidation  
23 is simply a natural extension to thawing conditions  
24 of the concepts that are well accepted and in common  
25 use in conventional soil mechanics. Now, if one didn't  
26 have this theory and if one were to rely only on  
27 field measurements of pore pressures, to give you an  
28 understanding of what goes on in thawing conditions,  
29 you would be limited because you would not have a sound  
30 basis for assessing what happens when conditions





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1 change. You're just limited to getting the data from  
2 the locations that you can -- which you can take  
3 measurements, you don't have a theoretical framework  
4 to relate this to conditions such as what happens  
5 when you accelerate the rate of thaw, things of that  
6 kind. So the view that one will concentrate on, field  
7 measurements to get pore pressures, has that limitation.

8 There is also a view that  
9 suggests one will rely only on the permeability of the  
10 soil to understand the pore pressure behaviour during  
11 thaw. Now that, in my view, just looks at half the  
12 physics and my experience results in an unacceptable  
13 approach to understanding pore pressure behaviour during  
14 thaw and results in fact in conclusions that can be  
15 on the unsafe side.

16 Those who have been studying  
17 the behaviour of thawing soils feel that C sub V can  
18 be evaluated with about the same accuracy as with  
19 comparable unfrozen soils, and hence employing thaw  
20 consolidation concepts contribute significantly to our  
21 judgment in the design process.

22 Now, Mr. Claridge challenged  
23 our measurements of high pore pressures, particularly  
24 in the Fort Norman land slide, which was one location  
25 that was a matter of some research a few years ago,  
26 and claimed that there was no additional field data on  
27 slopes which substantiate theory. In our research  
28 work, we cited evidence of high pore pressure measurements  
29 as supportive of the fact that thaw generates high  
30 pore pressures and can give rise to instability.



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1 He invited correction, if he  
2 is wrong, and it's fallen to me to offer some corrections.  
3 The data that I'm trying to cite at this time were all  
4 available<sup>in the</sup>/literature at the time of his evidence.

5 There is another case record  
6 of measured ~~high~~ pore pressures that is cited in a  
7 paper by McRoberts and Morgenstern, myself, on the  
8 stability of thawing slopes, and it's one that Mr.  
9 Claridge himself refers to in his evidence.



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1 In that paper we cite  
2 observations by Chandler of the study of slopes in  
3 Westspitzbergen using a piezometer or measuring  
4 device very similar to the one that we used in the  
5 Fort Norman landslide. Chandler also measured pore  
6 pressures of a similar magnitude to the one that  
7 we did.

8 Claridge further criticizes  
9 our measurements because they did not -- were not  
10 undertaken for<sup>a</sup> sufficient duration, they didn't allow  
11 time for some of the influence of actually installing  
12 the instrumentation to dissipate or to disappear, and  
13 the same paper that I have just cited presents several  
14 other measurements that clearly indicate that the  
15 test data that we presented reached equilibrium at a  
16 terminal value. These pressures rose or fell to a  
17 certain stable value that was characteristic of  
18 conditions in the ground and not of the method of  
19 installing the instrumentation.

20 Rather than dwell on the  
21 details of measurement, I finally add that any  
22 doubting of the reliability of the readings, and the  
23 message we draw from the readings is that high  
24 pore pressures exist and the soils are weak accordingly,  
25 could we set aside, if one studied in detail or  
26 read the report by McRoberts and myself, a study of  
27 landslides in the vicinity of the Mackenzie River  
28 Mile 205 to 660. This is Environmental Social Committee,  
29 Northern Pipelines, Task Force on Northern Oil Development  
30 Report No. 73-35.





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1 I might just draw a few  
2 excerpts from this report that describes in some  
3 detail the conditions under which we made our  
4 measurements. I am referring now to measurements  
5 being made in the Fort Norman landslide that Mr. Claridge  
6 was so critical of.

7 Certain tests were obtained,  
8 were made using the simple expedient of a  
9 hand probe, that is, we just push something in, on  
10 probing the very low effect of stress conditions  
11 were apparent. That is to say, there was low stress  
12 in the soil, the soil was weak.

13 Little resistance to penetration  
14 was met over the entire depth. Another description  
15 of some of the conditions in this site. Small mud  
16 boils up to three inches in diameter pit the surface  
17 of the silt run with waters slowly weeping out from  
18 the boil craters. This is clear visual evidence of  
19 artesian flow upwards in the material which is  
20 exactly the condition that we drew attention to in  
21 our measurement, the water flowing upwards, one  
22 doesn't have to make a measurement to actually  
23 discern it.

24 About half an hour after the  
25 probe piezometer was withdrawn from location P-1 a  
26 mudboil began to form in the hole vacated by the  
27 probe, a definite "plopping" noise could be heard and  
28 once the silt settled in the small puddle, a mud boil  
29 was found. Again, evidence of high pore pressures,  
30 consistent with our observations.



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1 A final one and there are  
2 others in this detailed description of our field  
3 studies.

4 "As excess pore pressures were measured  
5 it was evident that the soils in  
6 which measurements were made were  
7 very soft and could mobilize little  
8 sheer strength. As a result it  
9 was impossible to place the  
10 piezometer in the soil to be  
11 tested immediately adjacent to the  
12 operator. On the other hand, little  
13 thrust was required to insert the  
14 piezometer to the desired depth.  
15 This problem had been anticipated  
16 and a relatively long 25-foot lead  
17 was provided. The piezometer was  
18 placed by lashing the top of the  
19 rod at right angles to a long  
20 pole and allowing the piezometer  
21 to slowly sink under its own weight  
22 into the soil."

23 The message there, you couldn't walk on the ground,  
24 it was so weak, the water pressures were so high,  
25 the strength and the frictional material was so low  
26 that we had to put the device on a rod and stick it  
27 in at at distance.

28 So there is abundant  
29 evidence then in my mind, for the existence of high  
30 pore pressures. However, I would like to add that the



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1 conditions that we are measuring, encountered at  
2 the Fort Norman landslide that I have just cited,  
3 are very severe and by no means representative of  
4 naturally stable slopes, the site was studied for  
5 scientific purposes and represents the worst possible  
6 case. These conditions are certainly not applicable  
7 everywhere, but I would emphasize that there is abun-  
8 dant evidence in support of the existence of high  
9 pore pressures.

10 Q Thank you, Dr. Morgenstern.  
11 My last question in connection with the Foothills  
12 presentation revolves around the quotation from  
13 Mr. Claridge's evidence at page 9511 of the transcript  
14 which I will read. It is at line 14 and I quote:  
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1 "I would say that my concern is perhaps they, meaning  
2 N.E.S. or Arctic Gas, are bogged down in a heck  
3 of a lot of paper, that the studies  
4 seem to be very office-oriented and our  
5 difference in this regard and perhaps one reason  
6 why we don't have very many reports is that we  
7 have been concentrating on getting out and  
8 seeing the conditions as they are, making sure  
9 we understand the problems before we sit down  
10 and do a study that may in fact be in error be-  
11 cause of lack of observational data."

12 Can you respond to that  
13 criticism or that concern, sir?

14 WITNESS MORGENSTERN: Yes,  
15 this in my view is a very serious criticism, if for  
16 no other reason than Dr. Clark would have difficulty with  
17 his budgets, if he doesn't get out. I'd like to  
18 address it in some detail, since it's certainly not  
19 true. The members of the N.E.S., Arctic Gas geo-  
20 technical group who have been actively engaged in  
21 slope stability observations, permafrost both in the  
22 Mackenzie River Valley, North Slope of Alaska and  
23 Canada, as well as the interior of Alaska. This work  
24 has been under way in an intensive manner since about  
25 1971. With regard to this work, I could enumerate  
26 five segments of objectives and perhaps achievements.

27 First is the identification  
28 and classification of land slide types peculiar to  
29 the permafrost terrain, of interest to us here.

30 Secondly, the development  
of a qualitative understanding of how land slides





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actually fail in permafrost terrain, an analysis of the mechanisms.

Thirdly, the formulation of quantitative design methods consistent with the observed patterns of slope instability behaviour in permafrost terrain, and the identification of material properties and thermal boundary conditions and so on associated with this.

Fourth is the acquisition of site specific data from the testing, the critical testing of the design methods using real data for real locations.

The fifth objective has been the development of design techniques to be used in construction and subsequently remedial techniques which would stabilize slides prior to occurrence, or indeed after they might occur along the right-of-way.

Various reports have been issued by Northern Engineering, particularly on the first three items that I've cited, which are essentially complete, and work on obtaining site specific data and further design, further construction techniques, are currently underway. These reports contain references not only to the large areas traversed by the Arctic Gas route, but also to many other permafrost regions, and in this sense the techniques or the observational approach that we adopted draws from a large body of literature, apart from our own exhaustive field surveys and personal observations.

Now, there's certainly been



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1 a considerable effort undertaken by Arctic Gas on the  
2 actual proposed routes, the acquisition of site  
3 specific data for use in preliminary design, I'd  
4 like to clarify this, to set the record straight and  
5 itemize it.

6 First of all, a large number  
7 of aerial reconnaissances, I suppose, along the proposed  
8 right-of-way, <sup>from</sup> about 1971 to the present, have been  
9 undertaken by project personnel. All slopes along the  
10 proposed route, both in Alaska and in Canada, have  
11 been inspected by at least two geotechnical specialists.  
12 Many slopes have been visited on the ground, foot  
13 traverse is made, on the other hand many others have  
14 been inspected only by helicopter.

15 Arctic Gas has funded detailed  
16 slope stability investigation programs at a total of  
17 23 land sites, land slide sites, <sup>or</sup> potential slope  
18 problem sites. These sites are located at the banks  
19 of river crossings, other right-of-way slopes, or  
20 actually slopes that have failed. The cost of these  
21 programs easily amount to a million dollars just for  
22 drilling and logistic support alone, moreover there  
23 are plans at the moment for drilling at six more  
24 sites in the Inuvik-Travaillant Lake area later in  
25 October.

26 The third component of our  
27 activity is a program of laboratory testing on samples  
28 that have been acquired as a result of these programs,  
29 and this has been under way intensively since April of  
30 this year, and is scheduled to continue until August



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1 of 1976. Laboratory testing includes tests to obtain  
2 creep characteristics, strength behaviour of frozen  
3 and unfrozen soils, permeability, co-efficient of  
4 consolidation or  $C_{sub V}$  and other parameters that  
5 are used to describe soils.

6 Moreover, fourthly, the  
7 detailed program involving the insitu monitoring of  
8 slope deformations and pore pressures is under way at  
9 selected sites. Insitu tests consisting of sheer  
10 strength tests, using a vane device, insitu permeability,  
11 active layer depth determination, and so on, are being  
12 undertaken at selective sites in the discontinuous  
13 zone particularly.

14 I'd like to point out that the  
15 site studies encompass the entire range of expected  
16 **worst case** conditions from the ice core topography of  
17 the North Slope in Alaska in the continuous zone to  
18 the icy fine-grained glacial lacustrine slopes of the  
19 southern discontinuous zone.

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1 Attention has also been given  
2 not just to the sliding processes that, we find thaw  
3 consolidation theory helpful, but also to other  
4 processes of ablation, landslides generated by  
5 rainfall and so on.

6 Our studies have identified  
7 the range of slope failure mechanisms peculiar to  
8 permafrost terrain and as I pointed out it is not  
9 only the rather flat plainer sliding processes  
10 that we evaluate with the aid of thaw consolidation  
11 theory, but also mass movements induced by rainfall,  
12 ablation and other factors.

13 Our approach has never been  
14 to be wedded to a particular analytical theory, but  
15 to make use of our best understanding of the various  
16 mechanisms that we encounter to aid our judgment in  
17 developing a safe, environmentally acceptable  
18 design.

19 THE COMMISSIONER: Well,  
20 Dd. Williams thought you were too empirical and  
21 Dr. Claridge thought you were too theoretical, so --

22 A That serves our  
23 paradox, yes,

24 MR. GENEST: Sir, the only  
25 thing left are a couple of questions that Mr. Marshall  
26 has addressed to Dr. Harlan in connection with the  
27 evidence of Dr. Lewis and I wonder if we might be  
28 permitted to split ourselves.

29 THE COMMISSIONER: Yes.

30 MR. GENEST: And that will



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1 end our rebuttal on this aspect.

2 MR. MARSHALL:

3 Q Dr. Harlan, Dr. Lewis  
4 alluded to the fact that at the pipeline crossings  
5 of the Firth and Malcolm Rivers that there is no  
6 flow and he questions the input parameters used in  
7 the Arctic Gas's responses to question 38 of the  
8 Pipeline Application Assessment Group request for  
9 supplementary information. Could you comment on  
10 that, sir?

11 WITNESS HARLAN:

12 A Yes. In our response  
13 to question 38 we presented three examples --

14 Q 38, that was --

15 A In response to 38.

16 Q In question 38, yes.

17 A We presented three  
18 examples which we intended only to be illustrative of the  
19 types of river crossing situations that might be  
20 encountered and the possible effects of a chilled  
21 pipeline operation. It was not our intent, in this  
22 response, for these examples to be applied to a  
23 specific river crossing.

24 We agree with Dr. Lewis  
25 in the sense that at the pipeline crossings for both  
26 of these rivers there is no flow and in this perspective  
27 the case is more representative of our case three  
28 in which the river freezes to the bottom than the  
29 case under which it is given.

30 Q So if I understand  
you correctly you are putting forward the rivers simply



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1 as examples of a general type and not specifically  
2 to present them as illustrating a situation at the  
3 proposed crossing locations.

4 A That is correct.

5 Q Dr. Lewis understood  
6 you were using them for that purpose and you  
7 weren't.

8 A That is correct.

9 Q So there is really no  
10 disagreement with Dr. Lewis about this point.

11 A That is right.

12 Q Now, sir, on page  
13 10592 of the transcript Dr. Lewis made three recom-  
14 mendations and perhaps I could just go through them  
15 briefly. The first was that the proposed culvert  
16 should be incorporated into the proposed model.  
17 The second was that a field drilling program should  
18 be conducted to identify streams with significant  
19 ground water flow and to obtain realistic input  
20 data, and thirdly that the feasibility of the culvert  
21 technique should be tested in the field and if it  
22 proves feasible the culvert should be installed prior  
23 to chilled pipeline operation.

24 I was wondering, Dr. Harlan,  
25 if you wish to comment on those three recommendations  
26 of Dr. Lewis?

27 A Yes, I would. With regard  
28 to the first recommendation we have initiated  
29 modifications to the Battele program to include  
30 analysis of the culvert technique.



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Q And what about the  
second recommendation.

A In regard to the  
second we have proposed to CAGSL a combined geophysical survey and drilling program to be conducted in the vicinity of the Firth and Malcolm Rivers during the winter or '75 - '76.

THE COMMISSIONER: Of the  
Firth and Malcolm Rivers, yes.

A Yes.

MR. MARSHALL:

Q And this, you feel, is  
the main area of concern?

A Yes.

Q And this, you feel ;would  
deal with his second recommendation ?

A Yes.

Q Yes, sir, and about the  
third recommendation?

A This one, we are presently  
investigating the feasibility of the field test. At  
this point we are not able to make a firm recommendation,  
as what will be done.

Q Well, then, sir, do I  
take it that there is, or there is not, basic  
disagreement between your work and that of Dr. Lewis?

A There is not any basic  
disagreements.

MR. MARSHALL: Thank you, sir,

THE COMMISSIONER: You say  
you had been working along the same lines as Dr.





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1 Lewis where he was offering constructive criticism?

2 A Yes, and for the most  
3 part we have anticipated his concerns and have taken  
4 action before his testimony.

5 MR. GENEST: So the soft  
6 plopping sound that you hear is our closing our books.  
7 That terminates our rebuttal evidence, subject of  
8 course what we hear from Dr. Adam. I think that is  
9 the only thing that --

10 THE COMMISSIONER: Well, thank  
11 you gentlemen and we will see you again for  
12 cross-examination at a date to be arranged. We  
13 will adjourn the hearing until 10 o'clock tomorrow  
14 morning. The Yellowknife Community Hearing will  
15 be at 8 o'clock this evening and I suppose I am the  
16 only one in the room who really must be there other  
17 than the court reporters.

18 MR. GIBBS: The  
19 date to be arranged for the cross-examination of this  
20 panel, it is likely to be next week. I know that  
21 Mr. Hollingworth is -- not even of Dr. Morgenstern  
22 were concerned with the windows in his apartment  
23 building. I know that Mr. Hollingworth would like to  
24 talk to him about it at a fairly early date.

25 MR. SCOTT: I don't understand  
26 that last part. I was just saying that it  
27 didn't seem to be possible that the cross-examination  
28 of this panel could be held next week.

29 THE COMMISSIONER: I think  
30 it will have to be a date to be arranged. Just speak



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1 to Mr. Scott and Mr. Genest and whatever the three of  
2 you come up with is fine with me.

3 MR. GENEST: We will find  
4 a date when Mr. Gibbs is at the N.E.B.

5 MR. GIBBS: Monday.

6 (PROCEEDINGS ADJOURNED TO OCTOBER 17, 1975)  
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Vol. 73

AUTHOR

Mackenzie Valley pipeline inquiry:

Vol. 73

16 October 1975

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MACKENZIE VALLEY PIPELINE INQUIRY

Government  
Publications

IN THE MATTER OF APPLICATIONS BY EACH OF

- (a) CANADIAN ARCTIC GAS PIPELINE LIMITED FOR A RIGHT-OF-WAY THAT MIGHT BE GRANTED ACROSS CROWN LANDS WITHIN THE YUKON TERRITORY AND THE NORTHWEST TERRITORIES, and
- (b) FOOTHILLS PIPE LINES LTD. FOR A RIGHT-OF-WAY THAT MIGHT BE GRANTED ACROSS CROWN LANDS WITHIN THE NORTHWEST TERRITORIES,

FOR THE PURPOSE OF A PROPOSED MACKENZIE VALLEY PIPELINE

and

IN THE MATTER OF THE SOCIAL, ENVIRONMENTAL AND ECONOMIC IMPACT REGIONALLY OF THE CONSTRUCTION, OPERATION AND SUBSEQUENT ABANDONMENT OF THE ABOVE PROPOSED PIPELINE

(Before the Honourable Mr. Justice Berger, Commissioner)

Yellowknife, N.W.T.,

October 17, 1975.

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PROCEEDINGS AT INQUIRY

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WITNESSES FOR CANADIAN ARCTIC GAS PIPELINE LIMITED:

Guy Leslie WILLIAMS  
- In Chief

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G.L. Williams  
In Chief

Yellowknife, N.W.T.,

October 17, 1975.

(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

MR. GENEST: I'd like to recall Mr. Williams to adduce rebuttal evidence to the construction evidence led by Foothills Pipe Lines and by certain witnesses, principally Dr. Adam, who of course has not been completely cross-examined yet but at least from the E.P.B. Report, and with your leave, sir, I'd like to call him now.

I have distributed to my friends some documents which Mr. Williams will be referring to in the course of his examination in chief, and we'll be referring to them in due course.

GUY LESLIE WILLIAMS, recalled:

DIRECT EXAMINATION BY MR. GENEST:

Q Mr. Williams, first, sir, I would like to direct your attention to the evidence of the -- filed on behalf of the E.P.B., and that of Mr. Jarvis, who was on the Foothills' panels with respect to snow roads, and perhaps I could start by referring to page 31, Section 2, of the E.P.B. Report, that's the Environmental Impact Assessment Volume 4, Research Reports, which has already been filed in evidence, and I'd like to read a statement there that appears at page 31, as follows. It's under the heading:

"Criteria for seasonal limits. Criteria for setting seasonal limits on the use of winter roads in the western sub-Arctic





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1 and Arctic regions have not been systematically  
2 defined in the past. Historical data reflect  
3 when freight or construction equipment was  
4 available as much as they reflect the first  
5 date when a winter road was ready for use;  
6 similarly in spring, recorded dates reflect  
7 when the last vehicles withdrew from an area  
8 as much as they reflect the last possible date  
9 that vehicles could have safely made use of  
10 the winter road. However, from a few obser-  
11 vations of first and last days of winter road  
12 use during the last few years, the following  
13 criteria were established imperically for the  
14 limits of full winter road use.

15 1. Startup should occur following the accumu-  
16 lation of 8 inches -- that is 20 centimeters --  
17 of snowfall, and 550 degree days Fahrenheit of  
18 frost south of latitude 68. North of latitude  
19 68, startup should occur following accumulation  
20 of 4 inches, 10 centimeters of snow, and 550  
21 degree days Fahrenheit of frost."

22 And there appears a comment about shutdown, which is  
23 not of interest to us to the point I wish you to make,  
24 and the report goes on:

25 "The startup criterion was based on experience  
26 and the literature. Two independent studies  
27 concluded that something in the order of 550  
28 degree days of frost were required to assure  
29 a firm base for winter roads. Also 8 inches  
30



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In Chief

1 or 20 centimeters of snow were considered a  
2 minimum amount of material with which to con-  
3 struct winter roads, and at the same time offer  
4 protection to the terrain."

5 Reference to Adam.

6 "If insufficient snow exists on the right-of-  
7 way for snow road construction, the require-  
8 ment for 8 inches can be met by hauling  
9 snow in from lakes or rivers."

10 That is a statement, I believe, prepared by Dr. Adam,  
11 and I would like to contrast that with the evidence of  
12 Mr. Jarvis, given at -- given in the Foothills evidence,  
13 he provided a Table Y at the end of his testimony in  
14 chief which showed that major hauling could not start  
15 on snow roads before 1600 to 2000 degree days below 32  
16 degrees Fahrenheit had been accumulated along with eight  
17 inches of snowfall. It's a long preface, Mr. Williams,  
18 but in other words we have Dr. Adam in the E.P.B. Report  
19 stating that 550 degree days are required for full  
20 winter road use, and we have Mr. Jarvis saying that three  
21 to four times that amount is required. I'd like to ask  
22 you first of all, sir, to state your own view as to the  
23 number of freezing degree days that would be required  
24 for full use of snow roads and right-of-way operations,  
25 north of 60 degrees latitude, and then discuss the  
26 approaches of Mr. Jarvis.  
27  
28  
29  
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G.L. Williams  
In Chief

1 Can I ask you what your own  
2 views are on the subject?

3 A Yes, sir, and in my  
4 opinion there really is not one answer to this  
5 question, that in the 800 odd miles between Richards  
6 Island and the 60th parallel insofar as snow road  
7 construction is concerned, I think, that it should  
8 be divided into three areas, three basic areas and  
9 each area would have their own criteria.

10 In the northern section in the  
11 continuous permafrost zone where the active layer  
12 is very thin and one is looking for about eight inches  
13 of frost penetration as Mr. Longlitz suggested, that  
14 can be achieved in a very short period of time, less  
15 than 550 degree days.

16 From Fort Good Hope down  
17 toward Fort Simpson in the northern end of the dis-  
18 continuous zone there is a considerable amount of  
19 mineral soil and again, the active layer will be  
20 deeper. One may wish a slight increase in the depth  
21 of frost penetration in that zone, that is, something  
22 between 8 and 12, inches, say.

23 South of Fort Simpson there  
24 are vast areas of muskeg, peat land, bog land, whatever  
25 you want to call it and this type of terrain requires  
26 a substantially longer period to accumulate frost  
27 penetration. In that area I think that one would  
28 look closer to Mr. Jarvis' figures for the development  
29 of a suitable snowroad surface. His numbers vary, I  
30 think it is from 1600 to 2000 degree days. I would put



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In Chief

1 it, with proper procedures, I would put it below  
2 the lower limit, maybe in the 1000 degree day  
3 range.

4 Q Would you comment on  
5 Mr.Jarvis' approach to this problem?

6 A Yes, sir, on page 10027  
7 of the transcript, Mr. Jarvis discusses what he was  
8 able to learn about the Inuvik snow road test where  
9 there was about 12 inches of active layer. His  
10 testimony does not indicate it, but I would add that  
11 this active layer depth measurement was taken in  
12 October with the active layer near its maximum.  
13 Then on the same page, Mr. Jarvis states that this  
14 information is not much help to him in preparing  
15 construction schedules for Foothills spreads one and  
16 two as he has observed drill hole data which indicates  
17 an active layer of five to six feet thick.

18 Now, Foothills have not  
19 shown drill hole data on their alignment sheets north  
20 of Thunder River, at least we were unable to find  
21 it. Spreads one and two, that is Foothills' spreads  
22 one and two, which run from Richards Island down to  
23 a location just south of Thunder River or north  
24 of Little Chicago. I have however, examined our  
25 drill hole data and found one location in this  
26 area near the shoreline of the Mackenzie River where  
27 there was an active layer of about four feet.  
28 Another one or two thawed quite deeply drill holes are  
29 shown, but they are in gravel pits.

30 Q That doesn't help much,





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In Chief

1 does it?

2 A No, sir.

3 Generally, the range of  
4 depth of active layer was one to two feet and all of  
5 Foothills spreads one and two are located in the  
6 continuous permafrost zone and surely one would expect  
7 a shallow active layer. No doubt one could go out  
8 and find isolated areas near ponds or disturbed areas  
9 where the active layer is deeper, but these would be  
10 infrequent and would mostly be avoided in detailed  
11 route selection.

12 Q May I just interrupt  
13 you there, Mr. Williams. I take it then that you  
14 gather from Mr. Jarvis's evidence that some of  
15 his conclusions are based on estimates of the depth  
16 of the active layer in the areas of spreads one and  
17 two and you think that they are too high?



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In Chief

1 A Yes, I would say that's  
2 correct.

3 Q And the relevance of that,  
4 sir, is that the depth of active layer will determine  
5 the number of degree days needed for sufficient frost  
6 penetration?

7 A That is certainly one  
8 important aspect of it. The type of material, the  
9 sub-surface material is also important.

10 Q Would you proceed then,  
11 sir?

12 A At page 9850, Volume  
13 67 of the testimony, in answer to Mr. Templeton's  
14 question Mr. Jarvis names the N.R.C. publication No.  
15 12881 as his source of information in converting degree  
16 days to frost penetration. I have obtained a copy of  
17 this bulletin, and it's entitled:

18 "Freezing of Peatland,"  
19 and it's authored by R.J.E. Brown and G.P. Williams.

20 Q And is that one of the  
21 documents that we have distributed?

22 A Yes sir, it is. It's  
23 the largest sheaf of paper that we distributed this  
24 morning.

25 Q It sounds like the title  
26 of a novel, but I guess there's no country called "The  
27 Peatland".

28 A I don't know if I'm going  
29 to be in trouble with the Queen's Printer in duplicating  
30 so many copies of this document, Mr. Commissioner. I



G.L. Williams  
In Chief

1 might need some help later on down the line if I get  
2 into trouble. But anyway I'd like to read three para-  
3 graphs from this publication, which I think may help  
4 to resolve this discrepancy, and they're found on page  
5 2, and starting with --

6 Q Mr. Williams, Mr. G.P.  
7 Williams is no relative?

8 A No sir.

9 Q All right.

10 A Not to my knowledge.

11 Q Page 2?

12 A Yes sir, on page 2,  
13 starting at the first full paragraph:

14 "Three categories of peatland are described  
15 in the Muskeg Engineering Handbook relative  
16 to the distribution of permafrost. The first  
17 seasonally frozen is found south of the perma-  
18 frost boundary where the Mer Bleue peat bog  
19 is located. Peat ranges in thickness from 30  
20 centimeters to more than 6 meters. As the  
21 name implies, the surface frozen layer is  
22 entirely seasonal. The depth of frost pene-  
23 tration or thickness of the frozen layer is  
24 extremely variable, depending on climatic  
25 factors such as air temperature, solar radia-  
26 tion and snow cover. The second category  
27 is peatland in the discontinuous permafrost  
28 zone where Thompson is located."

29 Thompson, Manitoba.

30 "Observed peat thickness varies from 30



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In Chief

centimeters to 3 to 5 meters in rock basins and pulses. In the southern fringe of this zone, permafrost occurs in scattered islands a few square meters to several hectares in size, and is confined mainly to peatland."

THE COMMISSIONER:

Q How much is a hectare?

MR. GIBBS: 2.4 acres.

A 2.4 acres.

MR. GENEST: How many have you got on your farm?

MR. GIBBS: We're converting in Alberta.

A " Northward it becomes increasingly widespread and occurs in other terrain types also. Where permafrost exists in peatlands, the depth of the permafrost table is usually less than 1.5 meters. The active layer usually extends to the permafrost table, but a variation of this category may occur where an unfrozen layer exists through the winter between the seasonally frozen peat and the permafrost. Peatlands in the continuous permafrost zone comprise the third category. Observations have shown that these peat deposits are generally relatively shallow, their thickness seldom exceeding 1 meter or a few feet. Permafrost occurs everywhere beneath the ground surface, including all peatland. The active layer generally varies in thickness from about 0.3 to 1 meter in the





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In Chief

1 continuous zone, depending on climatic and  
2 terrain conditions, and it almost invariably  
3 extends to the permafrost table. The active  
4 layer is thinnest in peatlands, an annual  
5 depth of thaw of only 15 centimeters being  
6 observed in the Arctic Archipelago."

7 Now this publication deals at length with frost penetra-  
8 tion in peatlands near Ottawa and Thompson, Manitoba.  
9 In Mr. Jarvis' resume he indicates substantial exper-  
10 ience in winter road construction in Ontario and in  
11 Manitoba, and in Manitoba at least as far north as  
12 Thompson, which is located in the discontinuous permafrost  
13 zone.

14 Now Mr. Commissioner, I think  
15 that this is the basis of the problem. When constructing  
16 winter roads in the northern part of the provinces or  
17 the southern part of the Territories, the main problem  
18 is peatland or muskeg or bogland, and the difficulty  
19 one has in getting enough frost into these wet areas  
20 to support heavy construction equipment. If one waited  
21 for nature to take its course, a very large number of  
22 degree days would be necessary and may not be accomplish-  
23 ed at all unless some form of frost penetration induce-  
24 ment were used. That is precisely what we plan to do.

25 MR. GENEST: Q Can I stop you  
26 there again, Mr. Williams? If we're talking about the  
27 continuous permafrost zone, and if we take into account  
28 what was in the article by Brown and Williams that  
29 you've just read, what's the significance of getting  
30 frost penetration into that ground?



G.L. Williams  
In Chief

1 A I'm not sure that I  
2 understand that, Mr. Genest.

3 Q Would it be quicker or  
4 slower? Mr. Jarvis in his evidence seems to be saying  
5 it's going to take you a long time, and you say he's  
6 talking about really a bogland in the northern parts of  
7 Manitoba.

8 A Yes, we'll get into this  
9 as we go along, Mr. Genest, but what he is saying is  
10 that he would require -- or the time required to have  
11 30 inches of road bed.

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1 I think what we are going to be  
2 saying is that in the northern areas where the active  
3 layer is very shallow that as soon as you freeze off  
4 the active layer you have many hundreds of feet of  
5 frozen road bed.

6 Q Because you have frozen  
7 down to the permafrost?

8 A Yes, sir.

9 Q Right.

10 A In the coloured graphs  
11 supplied by Mr. Jarvis, which I think is filed as  
12 exhibit 258, you will probably recall these graphs,  
13 exhibit 258, he shows preparatory work starting generally  
14 in October. On page 9641 of the testimony he describes  
15 this work as compacting snow with low ground pressure  
16 vehicles to accumulate frost. Then on page 10027 of  
17 the testimony he says that he recommends twelve to  
18 fourteen inches of frozen material underlying the  
19 road surface before his next phase, which he calls  
20 construction, begins. I am sure that, he has also said, when he  
21 speaks about construction it is snow road construction that  
22 he refers to, not pipeline construction.

23 Then on page 10028 he says  
24 that he feels there should be at least 30 inches of  
25 roadbed before heavy hauling begins. I assume that  
26 the 30 inches includes the compacted snow plus the  
27 frozen sub-bed. This, he says, requires something  
28 like 2000 degree days and at best would not occur  
29 until around the end of November.

30 In response to your question,



1 sir, on the same page he says "this is the case  
2 for the Foothills spreads one and two which are in the  
3 continuous permafrost zone."

4 Now, in my opinion, sir, based  
5 on our experience and research, this is just not  
6 correct and I will try to explain the reasoning behind  
7 that statement.

8 Going back to the N.R.C.  
9 publication that he referred to in the third paragraph  
10 on page 2, it states that the continuous permafrost  
11 zone -- I am sorry, in the continuous permafrost zone,  
12 the active layer varies in thickness from 0.3 to  
13 1 meter and goes on to say that the active layer  
14 is thinnest in peat land, and in the far north as  
15 little as -- the active layer is as little as 15  
16 centimeters, or about 6 inches.

17 This is really common sense,  
18 as peat is a good insulator, as we mentioned it is a  
19 slow process to obtain frost penetration in the early  
20 winter in the southern areas, and conversely it is  
21 slow to thaw in the summer in northern areas, therefore  
22 a shallow active layer in peat lands in the north.

23 At the Inuvik snow road  
24 test site there was an active layer of 12 to 18 inches  
25 deep and we were able to get frost penetration to the  
26 permafrost table in a period of about one week in  
27 October. Work began on October the 23rd and at that  
28 point in time there was about 230 degree days of  
29 frost at October the 23rd, but there was little  
30 frost penetration in the undisturbed areas and after





G.L. Williams  
In Chief

1 repeated passes with a soft track Bombardier  
2 to assist in the frost penetration, full frost pene-  
3 tration was noted to the permafrost table on October  
4 the 30th, and this was after an additional 165 degree  
5 days, making a total at that time of 395 degree days.

6 In the undisturbed bush  
7 land adjacent to the snow road test right-of-way,  
8 full freezing was not noted until November the 7th,  
9 that is, from the surface to the permafrost table and  
10 this was after a total accumulation of 606 degree  
11 days of frost. This was in October of 1973.  
12 Of course once the active layer has frozen then,  
13 as we have said before, there are several hundreds  
14 of feet of solid road bed.

15 The required depth of  
16 frost penetration also depends on types of subsurface  
17 soil conditions that prevail. If one is down near  
18 the 60th parallel where there are vast areas of deep  
19 west muskeg or peat land I certainly agree that 30"  
20 of frozen road bed are desirable before heavy construction  
21 work begins, because below that 30" is wet, sloppy  
22 organic material, but if the subsurface material is  
23 damp mineral soil, a few inches, or at least less  
24 than a foot of frost is required to support heavy  
25 construction equipment.

26 Q That, Mr. Williams, I  
27 take it, is because of mineral -- the damp mineral  
28 soil you describe has sufficient strength, does it?

29 A It has some bearing  
30 capacity, providing there is a solid surface on top



G.L. Williams  
In Chief

1 to distribute the load to the softer materials below.

2 Now, near the back of this  
3 N.R.C. publication 12881 there is no page number,  
4 but it is listed as figure eight.

5 Q It is figure 8, it is  
6 about the sixth page from the back?

7 A That is pretty close.

8 Q Seven pages from the  
9 back.

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A      This graph shows the maximum depth of freezing on the vertical ordinate on the left-hand side, versus freezing degree days along the -- horizontally on the bottom, and I assume that this was the basis for Mr. Jarvis' criteria. It's the only place I could find in the publication that gives this information. Unfortunately, this graph is in the metric system and some conversion is required because the numbers supplied by Mr. Jarvis and Dr. Adam were in degrees Fahrenheit and inches.

Now I think we should look at the saturated peat curve, which is the second one from the bottom, as I think this was the governing factor used by Mr. Jarvis; but of course I'm not certain of this. On the left-hand vertical axis 30 inches is about 76 centimeters or about half-way between the 50 and the 100.

Moving horizontally from that point to intersect the curve, and then vertically downward, we intersect the horizontal axis at about 1200 centigrade freezing degree days. My calculation shows this to be about 2160 Fahrenheit degree days, or fairly close to the 2000 degree days quoted by Mr. Jarvis.

The curves as shown are for undisturbed terrain and I do not know what allowance has been made by Mr. Jarvis for compaction of the surface cover because as the soft track vehicles compact the snow on the peatland, they also compact the surface mosses and underlying peat, and thereby increase the thermal conductivity. In my opinion, this would reduce



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1 the criteria from 2160 Fahrenheit degree days at least  
2 down to the lower limit of Mr. Jarvis' scale of 1600  
3 degree days, in his Table "Y". Figure 8 also shows  
4 about 30 inches of frost penetration in silty clay or  
5 sandy soil, which is the next curve above the one we've  
6 been discussing, that after about 500 Centigrade degree  
7 days or 900 degree, Fahrenheit degree days there would  
8 be 30 inches of frost penetration in that type of  
9 material. As we said before, one really doesn't  
10 need 30 inches of frost penetration in mineral soil.

11 Mr. Longlitz suggests that  
12 about eight inches of frost penetration is adequate.  
13 In any event, I wish to emphasize that these degree  
14 days are for peatland or muskeg, and the route that  
15 we are proposing is not all, or even a large percentage,  
16 in this type of terrain. Certainly south of Fort  
17 Simpson there are substantial amounts of peatland  
18 terrain. Some thawed and some frozen. The construction  
19 schedule filed by Arctic Gas reflects this knowledge  
20 and suggests that the main aspects of construction may  
21 not begin until December. As examples, Arctic Gas  
22 spreads "E" and "F" near and south of Fort Simpson  
23 have 150 miles to construct in two seasons, while  
24 spreads "C" and "D", which are north of Fort Simpson,  
25 have 163 miles to construct in two seasons.

26 North of Fort Simpson there is  
27 considerably less peatland and much of it is permanently  
28 frozen. With judicial detailed route selection, we would  
29 expect to avoid many of the deeply thawed peat areas.

30 THE COMMISSIONER: I think





G.L. Williams  
In Chief

mean: judicious.

MR. GENEST: We hope so, sir.

A Does that require an  
answer, sir?

THE COMMISSIONER: No.

MR. GENEST: "Judicial" means  
that it would be selected by a judge, Mr. Williams.

A How come you didn't pick  
that out last night, sir?

(LAUGHTER)

I'm just a poor dumb engineer.

THE COMMISSIONER: Well, carry  
on. It's Friday morning and we're doing our best, Mr.  
Williams.

A Again Mr. Longlitz said  
that in his opinion about 8 inches of frost penetration  
is required along with adequate snow cover before winter  
work begins. The graph shown on figure 8 does not go  
low enough to determine the degree days required for  
eight inches penetration. But in this N.R.C. publication  
on page 9, and again in the reference section, reference  
is made to the work conducted in the field by the U.S.  
Corps of Engineers, and in particular reference is made  
to manual TM 5-852-6. I have obtained a copy of this  
manual and reproduced copies of the air freezing index  
which plots frost penetration in feet against degree  
days -- I'm sorry, against Fahrenheit degree days, and  
those two pages are also included in the handout this  
morning.

MR. GENEST: Sir, I wonder if



G.L. Williams  
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1 these might not be introduced as exhibits?

2 THE COMMISSIONER: Certainly.

3 MR. GENEST: The freezing of  
4 peatland, an article by N.R.C. and these tables.

5 Now I'll give a copy to Miss Hutchinson.

6 (ARTICLE RE FREEZE & THAW IN SOILS MARKED  
7 EXHIBIT 283)

8 ("THE FREEZING OF PEATLAND" BY BROWN & WILLIAMS  
9 DATED DECEMBER 1972 MARKED EXHIBIT 284)

10 MR. SCOTT: Is Table "Y" a part  
11 of the handout?

12 MR. GENEST: No, Table "Y" was  
13 part of the evidence of Mr. Jarvis, that he gave, that  
14 was attached to his direct testimony. I must say I've  
15 forgotten whether it was filed as an exhibit, but it was  
16 attached and he referred to it at some length.

17 A If you'll look for a  
18 minute at the graph that we just mentioned in the U.S.  
19 Corps of Engineers Manual, and again take the most diffi-  
20 cult curve shown there, the damp --

21 Q Sorry, Mr. Williams, could  
22 you tell us what it shows? Maybe I'm a little slow this  
23 morning. The graph is intended to show frost pene-  
24 tration again, is it the same sort of thing as the  
25 table that appeared in the N.R.C. publication?

26 A Yes, it's very similar  
27 to that, Mr. Genest. On the left-hand vertical axis  
28 is a frost penetration in feet, and on the horizontal  
29 axis for the main curve is plotted degree days, and this  
30 chart doesn't say so but I'm pretty sure that it's



G.L. Williams  
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1 Fahrenheit degree days. I'm positive the degree days  
2 shown on the horizontal axis are Fahrenheit degree days.

3                                So if you look at the upper  
4 curve, the worst case situation, the clay and damp  
5 topsoil, and go up to the top, up near the top left-  
6 hand corner and pick off eight inches of frost pene-  
7 tration, which is only about a little better than a  
8 quarter of an inch down from the top left-hand corner,  
9 and move horizontally to intersect the curve, and then  
10 vertically upward, we see that for <sup>FOR</sup> bare ground or  
11 pavement, snow-free, that the degree days for eight  
12 inches of frost penetration would be around 300 degree  
13 days. Then if you continue on a vertical line upward  
14 to the next set of lines, which is turf, snow free,  
15 that we see that for that situation again with the same  
16 type of sub-soil, but this time with a grass cover,  
17 we require about 600 degree days, Fahrenheit degree  
18 days; and moving on up further to the turf with 12  
19 inches snow cover, about 1000 degree days would be  
20 required for eight inches of frost penetration.  
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G.L. Williams  
In Chief

1 In summary then, I am in  
2 closer agreement with Dr. Adam's criteria with respect  
3 to the availability of full winter road use, that is,  
4 550 degree days and four to eight inches of  
5 snowfall depending on the latitude for areas where  
6 there is a thin active layer, or for other areas  
7 that have subsurface materials composed mainly of  
8 mineral soils. Areas that have a high percentage  
9 of peat land, such as that south of Fort Simpson, I  
10 think a greater number of freezing degree days are  
11 necessary, possibly something like 1000 freezing  
12 degree days, and this number is difficult, if not  
13 impossible, to obtain from the graphs which we have  
14 looked at as they do not take into account acceleration  
15 of frost penetration through snow and surface vegetation  
16 compaction. Our construction schedule assumes that  
17 this procedure will be used.

18 On pages 9712 and 9713 of the  
19 testimony Mr. Jarvis has stated that in his coloured  
20 graphs, again exhibit 258, the gap between the start  
21 of winter road construction and start of hauling is  
22 the time required to construct the road along the  
23 full length of the spread, and in the case he was  
24 talking about something like 45 miles, I think.

25 Later in his and Mr. Kosten's  
26 cross-examination, they agreed that hauling or pipeline  
27 construction could start as soon as a mile or two of  
28 properly constructed road was ready. Mr. Longlitz  
29 and Dr. Adam also concur in this procedure.

30 Mr. Jarvis further agreed on





G.L. Williams  
In Chief

1 page 9732 that if one was prepared to accept the  
2 costs of providing artificial compacted snow cover,  
3 that construction could start much earlier.

4 On page 9733 and following,  
5 Mr. Scott suggests that this was a hypothetical  
6 case and not part of the Arctic Gas case.

7 Q Perhaps I could  
8 interrupt you there, Mr. Williams, to refresh everyone's  
9 memory. That part of the transcript, Mr. Commissioner,  
10 I was cross-examining Mr. Jarvis on the points that  
11 Mr. Williams is now making and Mr. Scott said this,  
12 perhaps I can read it. He said:

13 "Mr. Genest has presented an interesting hypoth-  
14 etical to the panel. Is Mr. Genest suggesting  
15 that that's what Arctic Gas proposes to do,  
16 because if it isn't what they propose to do  
17 it's an interesting but totally theoretical  
18 debate that is consuming some time."

19 And there was then some discussion about what we were  
20 proposing to do and this evidence is directed to that  
21 issue.

22 Would you proceed, then,  
23 Mr. Williams?

24 A Yes, sir.

25 Q -- to comment on that.

26 A We have said before  
27 at this Inquiry, and I would like to repeat it, that  
28 it is Arctic Gas's plan to have people and equipment  
29 available in the early part of the fall, or early  
30 winter, fall season at all spreads to begin snow or



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In Chief

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1 winter road construction as soon as weather conditions  
2 permit and that pipeline construction crews would  
3 be brought in to begin as soon as a few miles of  
4 properly prepared snow road and right-of-way were  
5 available.

6 In my view this would be  
7 at the latest, early November at the north end and  
8 early December in the area south of Fort Simpson.  
9 Techniques of frost inducement would be applied,  
10 techniques of enhancing natural snow would be used  
11 where required, including snow fences in the northern  
12 barren areas, snow manufacturing and snow hauling.  
13 from frozen lake surfaces, these procedures would be  
14 implemented to allow an early start of construction.

15 Q Mr. Williams, I would  
16 like to move now to statements made, in particular  
17 by Mr. Mirosh, on behalf of Foothills in the Foothills  
18 direct testimony where a statement was made that  
19 Foothills considered that Arctic Gas had overestimated  
20 the productivity of spreads that was attainable,  
21 they questioned our ability to complete the work in  
22 the time that we had laid out in our construction  
23 plan and said that we had considerably overestimated  
24 productivity of spreads.

25 Could you comment on that,  
26 sir?

27 A Yes, sir, and as an  
28 example I would like to take the case of the Inuvik  
29 area which, I think, is a worse case situation where  
30 the difference in seasonal mileage productivity between



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1 Arctic Gas and Foothills is the greatest, and in  
2 that handout this morning we have a table that  
3 compares the situation.

4 Q That is the short  
5 little table with a number of columns, company total  
6 miles, total calendar days available?

7 A Yes, sir.

8 MR. GENEST: What title can  
9 you give that? Should I tender that as an exhibit,  
10 I would like to tender that, sir.

11 THE COMMISSIONER: Please.

12 A Productivity  
13 Comparison, Inuvik Area.

14 MR. GENEST: All right.

15 (TABLE ENTITLED "PRODUCTIVITY COMPARISON, INUVIK AREA"  
16 MARKED EXHIBIT 285)

17 THE COMMISSIONER: That is  
18 this one?

19 MR. GENEST: That is that one,  
20 sir. "Productivity Comparison, Inuvik Area" What it  
21 does, sir, is compare some Foothills numbers with  
22 some Arctic Gas numbers.

23 MR. GIBBS: Could we have  
24 the exhibit numbers of these that have been marked  
25 so far this morning?

26 THE SECRETARY: The last  
27 one was 285, and the ones before this were 283 and 284.

28 MR. GIBBS: 284 --

29 THE SECRETARY: The other one  
30



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1 this morning was 283, the geotechnical manual.

2 THE COMMISSIONER: The  
3 U.S. Army, whatever it is, the Airforce.

4 MR. GIBBS: And the new  
5 one now is 285 then?

6 THE SECRETARY: Yes.

7 A At the northern end  
8 of the system, in the general Inuvik area Foothills  
9 is planning to construct about 45 miles of pipeline  
10 per winter season. Arctic Gas's numbers are 74  
11 miles. Mr. Kosten suggested that those 45 miles  
12 require 90 calendar days. Mr. Dau in his last  
13 appearance here filed a table suggesting 136 calendar  
14 days to achieve the 74 miles proposed by Arctic Gas.

15 Mr. Kosten suggested that they have an allowance  
16 of about 25% reduction in calendar days due to weather  
17 and one thing and another, that would leave a total  
18 of 67.5 working days. Mr. Dau has in his table  
19 that was produced here, 92 working days which is a  
20 reduction from the calendar days of about 32%.

21 So, for the Foothills estimate  
22 they must construct 0.5 miles per calendar day; Arctic  
23 Gas 0.54 miles per calendar day, a difference of  
24 4/100ths of a mile or about -- under 210 feet, and  
25 on a working day basis it is greater. Foothills  
26 would construct 0.67 miles per working day; Arctic  
27 Gas 0.8 miles, a difference of 0.13 miles, or about 690  
28 feet.









G.L. Williams  
In Chief

1 Q And they say they can't  
2 begin till January 1st for the reasons their panel  
3 gave me -- snow roads, darkness, safety and so forth --

4 MR. GENEST: Sir, if I may  
5 interrupt, they say they really can't start till around  
6 the 1st of January or the end of January.

7 THE COMMISSIONER: I'm sorry,  
8 the end of January, 1st of February, and you say that  
9 you think you can begin around November 1st. That's  
10 a 3-month jump on them, November, December, January.

11 A Yes sir.

12 Q So that's really -- that's  
13 the big dispute at this point.

14 A It is a big difference,  
15 yes, in construction scheduling, yes sir.

16 Q In fact, it gives you a  
17 season that's virtually twice as long.

18 A Yes sir.

19 MR. GENEST: Q What do you say,  
20 Mr. Williams, as to the Foothills position that they  
21 shouldn't start till the end of January, beginning of  
22 February?

23 A Well, in my opinion, sir,  
24 this simply makes no sense at all. I think that the  
25 earliest possible starting date should be taken advant-  
26 age of. If our estimate of 136 calendar days is  
27 correct, then we will complete in mid-March. If we  
28 have under-estimated our productivity, then there is  
29 at least one month cushion to complete the work on  
30 schedule.



G.L. Williams  
In Chief

1 THE COMMISSIONER: At the  
2 end?

3 A Yes sir. That's based  
4 on a shutdown on April 15th, as opposed to Foothills'  
5 suggestion of late -- end of April, I think.

6 Q And you say that if they  
7 wait until February 1st to begin, in the Inuvik area,  
8 they may well be hard-pressed to complete even their  
9 limited schedule within -- before the season ends.  
10 They have no cushion at the end of the season as you  
11 do.

12 A They have no contingency  
13 cushion. Whether or not they can achieve that mileage,  
14 sir, in an average year, I would think it's possible.

15 Q But at any rate they  
16 should be able to build snow roads by February 1st.

17 A I would think so, sir,  
18 yes.

19 MR. GENEST: Q Well now, follow-  
20 ing up on that, Mr. Williams, as I understood the  
21 Foothills evidence, the reason for these late starts  
22 was, chiefly, as I understood it, the fact that  
23 they didn't wish to work in the darkness and didn't  
24 wish to work under artificial light.

25 THE COMMISSIONER: Lighting  
26 wasn't feasible.

27 MR. GENEST: Lighting wasn't  
28 feasible, that's right.

29 THE COMMISSIONER: The  
30 gentleman with the great name, as I recall, forgive me



G.L. Williams  
In Chief

1 I've forgotten it.

2 MR. GENEST: Kosten?

3 THE COMMISSIONER: Kosten, yes.

4 MR. GENEST: I don't know if  
5 he said lighting wasn't available, sir.

6 THE COMMISSIONER: No, he said  
7 it wasn't feasible.

8 MR. GENEST: It wasn't feasible  
9 because of safety considerations, and I wanted your  
10 comments on that, Mr. Williams.

11 A Yes sir, we've again  
12 prepared and have passed out or circulated this morning  
13 three tables.

14 THE COMMISSIONER: Excuse me,  
15 Mr. Genest, how are we doing here? Are we about half-  
16 way through?

17 MR. GENEST: I'm almost finished,  
18 sir.

19 THE COMMISSIONER: Well, let's  
20 stop for a cup of coffee for a minute, and then come  
21 back for the last lap.

22 MR. GENEST: About ten minutes  
23 or more.

24 (PROCEEDINGS ADJOURNED FOR A FEW MINUTES)  
25  
26  
27  
28  
29  
30





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In Chief

1 (PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

2 THE COMMISSIONER: Maybe  
3 we could just call the meeting to order, ladies  
4 and gentlemen.

5 MR. GENEST: We were talking  
6 about Foothills' fear of the dark and and we had  
7 put in a table, Mr. Williams called Working Light--  
8 there were three tables actually. One was  
9 entitled "Working Light at Fort Simpson, " "Working  
10 Light at Norman Wells", and "Working Light at Inuvik."  
11 Could I have these entered -- perhaps you could tell  
12 us what is the source of these, sir.

13 A Yes, sir, the source  
14 of this information are the Smithsonian Meterological  
15 Tables. There is quite a large textbook that covers  
16 this sort of material.

17 MR. GENEST: Could I introduce  
18 this as one exhibit, sir?

19 THE COMMISSIONER: Yes.

20 (TABLES: WORKING LIGHT, FORT SIMPSON, NORMAN WELLS  
21 AND INUVIK MARKED AS EXHIBIT 286)

22  
23 MR. GENEST: Would you take  
24 us through these, Mr. Williams.

25 A Yes, sir, the tables  
26 show the working light hours available at Fort  
27 Simpson, Norman Wells and Inuvik, and they include  
28 the duration of daylight, that is between sunup and  
29 sunset plus the duration of civil twilight and in  
30 the Smithsonian tables on page 506 they define civil



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1 twilight as the interval between sunrise or sunset  
2 and the time when the true position of the centre  
3 of the sun is 6 degrees below the horizon at which  
4 time stars and planets of the first magnitude are  
5 just visable and darkness forces the suspension of  
6 normal outdoor activities.

7                               They have a further definition  
8 of -- I haven't used it, but they have a definition  
9 here of astronomical twilight if anyone is interested,  
10 but the tables that we have prepared are based on  
11 the duration of daylight between sunrise and sunset  
12 plus the duration of civil twilight. If we look at  
13 them we can see that among other things, at Fort  
14 Simpson on the first page the available working hours  
15 in December are not much worse than January when  
16 Foothills plans to start work.

17                               Similarly, November is not  
18 that much different from February.

19                               On the next page at Norman  
20 Wells, the situation is similiar and you will note  
21 that there are some pretty short working days in  
22 January when Foothills plans to be working.

23                               At Inuvik on the third page,  
24 the latter part of January and the first half of  
25 February there would be some very short working days  
26 for Mr. Kosten if he did not plan to use artificial  
27 lighting.

28                               Just getting away from the  
29 tables for a minute, Mr. Commissioner, when in Alaska,  
30 I noted, as I am sure that you did, that the crews



G.L. Williams  
In Chief

1 that were installing the V.S.M's, the Vertical Support  
2 Members --

3 Q What are vertical --?  
4 Well, I understand those would be called piles if  
5 it weren't for union problems.

6 A Yes, they are the 18"  
7 diameter pipe supports that support the above ground  
8 portion of the pipeline.

9 THE COMMISSIONER: They are  
10 rather more elaborate than any wooden piles that I  
11 have ever seen. They are not wooden, they are  
12 steel.

13 MR. GENEST: I withdraw  
14 the comment.

15 THE COMMISSIONER: No -- actually  
16 that is what I am sure drives the cost of an elevated  
17 line up because those are very elaborate structures  
18 in themselves, each one of them, and at any rate, you  
19 were going to make a comment, don't let me divert  
20 you.

21 A Yes, they certainly are  
22 elaborate, the anchor materials that have to be  
23 fabricated, I am sure -- I don't have a cost on  
24 them, but I would guess are extremely costly.

25 THE COMMISSIONER: And they  
26 have to move to ensure that if an earthquake occurs  
27 the pipeline isn't twisted and -- well --

28 A Anyway, as we were  
29 saying, I am sure that you noticed that the crews  
30 that were installing the vertical support members, were



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In Chief

1 double shifted and they worked around the clock with  
2 the aid of floodlights. Now, it may be argued that  
3 this is not comparable to pipeline construction, but  
4 let's just consider for a minute some of the equipment  
5 that they do use in that operation.

6 First of all, there are  
7 very large drill rigs that are required to drill the  
8 holes and of course they have to move along the  
9 right-of-way. There are large hoists that are required  
10 to lift and set the pipe supports.





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In Chief

1 Large concrete trucks are  
2 required to provide the backfill slurry. Additional  
3 equipment is required to vibrate the pile and consoli-  
4 date the slurry once it's in place, and then another  
5 large piece of equipment is required to expand or  
6 corrugate the pipe -- the bottom section of the pipe,  
7 and of course large mobile air compressors are required  
8 for some of the drilling rigs.

9 As to the safety aspect, we've  
10 recently contacted two of the contractors that are  
11 working on the Alyeska Pipeline, and they advise that  
12 they have not found any measurable difference either  
13 in the productivity or the accident rate between the  
14 two shifts. That is the productivity and the accident  
15 rate between the one working at night and the one in  
16 the daytime is about the same.

17 THE COMMISSIONER: Excuse me,  
18 Mr. Williams, this is an important point.

19 Mr. Scott, allegations have  
20 been made that I know you and your staff intend to  
21 explore regarding the accident rate on the Alyeska,  
22 that Mr. Williams says would indicate that it isn't  
23 owing to working in darkness. If in fact there are  
24 accident rates on the Alyeska line are as high as  
25 they are alleged to be, it maybe that it is owing to  
26 the lengthy hours that are being worked, it maybe owing  
27 to inexperienced workers, it maybe owing to high-balling  
28 or it may be the allegations that have been made are  
29 simply unfounded. At any rate, that's a matter that  
30 should be explored and you might find out from



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1 Mr. Williams the names of the people he's been in touch  
2 with, and make sure that is pursued.

3 MR. SCOTT: Perhaps he can  
4 tell us right now.

5 THE COMMISSIONER: Sure.  
6 If you want to.

7 A The people that this was  
8 discussed with?

9 THE COMMISSIONER: The companies.

10 MR. SCOTT: If that's known;  
11 if it's not, perhaps we could be provided at some  
12 other time.

13 A Yes, our discussions  
14 were with Perini Construction, the Majestic  
15 Wylie group, and Arctic Constructors. The Perini  
16 spread is the second one from the south.

17 MR. GENEST:

18 Q How do you spell that?

19 A Perini -- P-E-R --

20 Q Perini?

21 A Yes.

22 Q Sorry.

23 A They have the second  
24 spread from the south, it's centered around Big Delta,  
25 and Northern Constructors have the most northern two  
26 spreads.

27 THE COMMISSIONER: Fine.

28 Members of the Commission staff are going to Alaska  
29 next month to investigate those allegations, that's  
30 why I raise it now.



G.L. Williams  
In Chief

1                   A     I should say that in  
2 this conversation we put it to them cold, they didnt  
3 indicate they had kept any records, but there was  
4 nothing that they could think of that would -- of  
5 course the record of the productivity, they have that  
6 and they're vitally interested in that; but the accident  
7 rate, whether or not the contractors have kept statis-  
8 tics, I'm not sure, but the point is that if there was  
9 a large difference you would certainly think that  
10 they would be aware of it.

11                   Q     I know, you would think so.  
12 I'm not suggesting that you're saying that that disposes  
13 of the whole question forever. But it is an important  
14 one and we'd like to take a look at it ourselves.  
15 That's really what I'm saying.

16                   A     Certainly . Then further,  
17 they have advised that they have not heard of any other  
18 contractors having difficulty in this procedure. They  
19 advised that this statement applies both to the gravel  
20 pad construction, which was started last winter, which  
21 was also double-shifted, and to the V.S.M. installation  
22 which is still proceeding on a double-shift basis.

23                   With respect to the small  
24 diameter Alyeska Gas Pipeline that was mentioned a  
25 week or so ago at this Inquiry, we're advised that  
26 it's planned for construction this winter, that it's  
27 a fuel gas line mainly 8 5/8 O.D. diameter pipeline,  
28 with some 10 and 6-inch pipe, and it's about 150 miles  
29 long, to be built off a snow pad parallel or near to  
30 the haul road, and running south from its origin at



G.L. Williams  
In Chief

1 Prudhoe Bay. The present plan is to start this  
2 small diameter gas line construction in November for  
3 completion in March, 1976. That is November '75 to  
4 March '76, and the people that are going to be doing  
5 the work that we talked to advised that they don't  
6 anticipate any great difficulty in working through  
7 periods of very little daylight.

8 MR. GENEST: Q Lastly, Mr.  
9 Williams, I'd like to, in response to a request by  
10 Mr. Goudge, we've been provided with certain data  
11 coming from Mr. Longlitz with respect to recent  
12 experience of startup and shutdown dates, and I'm not  
13 sure, I think that's also been distributed.

14 A No sir.

15 Q Oh, it hasn't?

16 A But it is an exhibit,  
17 it's Exhibit No. 280.

18 Q Oh, I'm sorry, that's  
19 fine, and I believe Mr. Goudge wished us to comment  
20 on this. Can you -- this exhibit, Mr. Commissioner,  
21 is a letter from Mr. Roy Gilmore, Assistant District  
22 Superintendent Northwest Lands & Forest Services  
23 to Mr. Bob Morrison, and he said he had dug through  
24 his diaries on land use files and had come up with  
25 some information on startup and shutdown dates.

26 Would you comment on this?

27 A Yes sir. I'm not sure  
28 that Mr. Goudge asked us to comment on it, but we  
29 asked for this information.

30 Q Oh, I see. I'm sorry.





G.L. Williams  
In Chief

1 A I don't plan to read it  
2 all into the record, but there are a few significant  
3 dates that I'd like to just touch on briefly.

4 The first --

5 THE COMMISSIONER: Excuse me,  
6 this is it, is it?

7 Exhibit "D", it says,  
8 "Exhibit D" in the corner.

9 A No, you don't have a  
10 copy of this, Miss Hutchinson could probably supply it.

11 MR. SCOTT: Perhaps it could  
12 be copied later and circulated to everybody.

13 A The first two pages deal  
14 with the Fort Simpson area, and I'm not certain or sure  
15 what the extent of the Fort Simpson area is in Mr.  
16 Longlitz' department, but I assume it's not far from  
17 Fort Simpson; and the record starts in 1972, and the  
18 first date is April 12th, where he says:

19 "Shutdown of winter travel."

20 Then going on to the fall of  
21 that same year, 1972, October 30th,

22 "D.P.W. of Northwest Territories opening  
23 winter road from Trout Lake but ground  
24 not frozen, and some surface disturbance  
25 occurring."

26 It would probably be nice to have a bit of background  
27 on that to see what equipment was used, and whether  
28 they tried any frost induction. Certainly the Trout  
29 Lake area is in an area of -- where there are substant-  
30 ial areas of thawed peatland.



G.L. Williams  
In Chief

1 THE COMMISSIONER: Could I  
2 stop you for a minute? You mentioned "frost induction"  
3 and you mentioned it before; how do you go about  
4 inducing frost penetration simply by putting snow on  
5 -- simply by adding snow to the surface, thus increas-  
6 ing the insulator, is that --

7 A No sir.

8 Q Now do you do it?

9 A Pretty well the opposite  
10 to that.

11 Q I see.

12 A As soon as weather  
13 conditions allow with it getting cold in the  
14 fall and a bit of snow cover, take a low ground  
15 pressure vehicle and --

16 Q Remove the snow?

17 A No. Compact the snow.  
18 Compact the snow, and at the same time the surface  
19 vegetation cover is compacted, and in that compaction  
20 you increase the thermal conductivity of the surface  
21 layer, allowing the frost to penetrate more rapidly.  
22  
23  
24  
25  
26  
27  
28  
29  
30



G.L. Williams  
In Chief

1 In this case we are  
2 dealing with mainly, as I say, with peat lands in  
3 the southern area where you want substantial thicknesses  
4 of cross penetration to support the heavy construction  
5 equipment.

6 THE COMMISSIONER: When thorough-  
7 out you have been speaking of inducing frost penetration  
8 that is the procedure that you would use?

9 A Yes, sir.

10 It was used at Inuvik, I think  
11 we showed some slides showing the procedure.

12 THE COMMISSIONER: Well, it  
13 has been four months since we saw the slides, I think,  
14 so -- forgive me for forgetting, but -- go ahead,  
15 that is fine.

16 A We did show, well, in  
17 the Inuvik test, that frost penetration could be  
18 accelerated, and it is standard procedure for  
19 snow road construction, no matter where in the north  
20 you are trying to build a road. Maybe I should just  
21 back off that a bit to say it is standard procedure.  
22 It is with respect to pipeline construction where an  
23 early start is considered necessary to meet construction  
24 the schedule.

25 Now, geophysical crews and  
26 rig moving crews in the north, I don't think use  
27 it that extensively. It does add to the cost and  
28 if their schedules allow they wait for the frost  
29 penetration to occur naturally and then they start  
30 their work, but that is strictly a matter of cost and



G.L. Williams  
In Chief

1 we say that we are prepared to accept that cost that  
2 is included in our cost estimates, it is the only  
3 way that we think that construction should proceed  
4 to assure a timely completion.

5 THE COMMISSIONER: When you  
6 say that compacting the snow increases the thermal  
7 conductivity, you mean from the atmosphere into the  
8 ground?

9 A Yes, sir.

10 Reading on down this list,  
11 on November 14th, D.P.W. geotechnical crew started work-  
12 ing at the Blackwater River; November 22nd Reason  
13 Construction Ltd. started centre line clearing north  
14 of Camsell Bend, and this is certainly in the general  
15 Fort Simpson area.

16 November the 24th Imperial  
17 Oil moving rig into the Dahadinni area north-  
18 west of Wrigley. Then moving on down to the  
19 spring of 1973 following that winter, in mid-April  
20 again the shutdown on winter travel. Going through  
21 the next fall and November the 7th, Hire North  
22 on right-of-way clearing using cats for piling brush  
23 at Camsell Bend and Blackwater River.

24 Now, if they started that  
25 work in accordance with Mr. Longlitz's requirements,  
26 that says that you could start clearing at Camsell  
27 bend on November the seventh, this is fairly early.  
28 Again in '74 in the Fort Simpson area, shutdown of  
29 travel on winter roads occurred April the 15th.

30 The next couple of items are





G.L. Williams  
In Chief

1 interesting. In the fall of 1974 heavy snow occurred  
2 on October the 15th and on October the 17th two  
3 feet of snow at Blackwater River, Hire North  
4 snowpacking roads using Bombardier very little  
5 frost in the ground. So there on October the 17th,  
6 1974 Hire North are doing what we suggest Arctic  
7 Gas would also be doing about that time.

8 Moving on to the --

9 THE COMMISSIONER: Excuse  
10 me, that last paragraph is interesting, he says  
11 that he thinks that more damage can be done by allowing  
12 late spring travel than by allowing early start up.

13 A Yes, sir, I agree, that  
14 is interesting. I should have read it in.

15 The last sentence of that  
16 paragraph says that except in the very odd year it  
17 would appear anticipated start up date would be no  
18 earlier than November the 7th.

19 Q So you would say that  
20 supports your argument that further north, the  
21 November 1st date would be realistic.

22 A Yes, and I think that  
23 the next two pages might illustrate that, Mr. Commissioner,  
24 which is taken from a report by the Land Use District  
25 Officer in the Inuvik area and the first item there  
26 on October the 29th, and this is in the 1973 -74  
27 construction season, that the use of a Bechtel  
28 rologon, 15 tons, initial road preparation on frost  
29 depth of five inches with snow three to six inches and  
30 this was on October the 29th, 1973.



G.L. Williams  
In Chief

1 That was for one particular project, the Gulf  
2 winter road near Parsons Lake.

3 Again, down near the bottom  
4 of that first page, another Gulf project, the same  
5 procedure started October the 26th, 1973, and on  
6 the last page, on another Gulf project and it is  
7 noted that it is in the tundra area, that on  
8 October the 9th, 1974, the use of delta three in  
9 preparation of Rat Airstrip. Again, I presume  
10 that that was snow compaction work. Again at another  
11 project on October the 15, 1974, dragging winter  
12 road and repairing road, and then later on they went  
13 on to do some flooding and icing of roads.

14 I understand that Gulf do  
15 have a snow manufacturing machine, a ski hill  
16 type gun at their camp near Swimming Point and they  
17 do use it to augment snow cover mainly on winter  
18 airstrip construction. We plan to monitor that  
19 work and it is due to start any day now.

20 MR. GENEST: Sir, that  
21 concludes my examination in chief of Mr. Williams,  
22 leaving only, sir, whatever rebuttal we might have  
23 after we have heard Dr. Adam's cross-examination.

24 MR. SCOTT: Mr. Commissioner,  
25 I think it is proposed by all counsel, if you don't  
26 object, that assuming Mr. Williams will be here some-  
27 time next week, we defer cross-examining him  
28 next week. In the nature of the problem it is difficult  
29 to give an advance notice of what is to be discussed  
30 and so I think all of us, with one or two exceptions



G.L. Williams  
In Chief

1 much of what Mr. Williams says is new and fresh.  
2 So, do I understand, Mr. Genest, that Mr. Williams  
3 won't be too far away next week, or will he be --?

4 MR. GENEST: Let me ask  
5 Mr. Williams.

6 A I have not received my  
7 instructions for next week Mr. Genest.

8 MR. SCOTT: Well, at the  
9 very worst, Mr. Williams is on the panel that relates  
10 to phase II and III, panel number 1, and so he cannot  
11 be too far away, though he may not be present early  
12 in the week.

13 THE COMMISSIONER: He might  
14 be at the end of a table.

15 MR. SCOTT: Well, he will  
16 be in his usual place.

17 MR. GENEST: Without the  
18 doctorate.

(WITNESS ASIDE)

19 MR. SCOTT: If that is  
20 acceptable, Mr. Commissioner, I would just like to  
21 run through briefly the work that we propose for  
22 next week. Messrs. Weedon and Parker will be recalled  
23 at the beginning of the week to be cross-examined by  
24 all participants. Mr. Marshall I think commenced  
25 the cross-examination of one or both of them, but  
26 indicated he was not finished and we will continue  
27 and complete their cross-examination.

28 THE COMMISSIONER: Yes,  
29 Mr. Banfield -- or Dr. Banfield, a witness for Arctic  
30 Gas at Whitehorse, gave evidence and was severely



1 critical of Dr. Weedon, the biologist from Alaska. I  
2 take it that Dr. Weedon has seen a transcript of  
3 what Dr. Banfield said about him.

4 MR. SCOTT: I don't know  
5 that, sir, he is Mr. Anthony's witness.

6 THE COMMISSIONER: Oh, he  
7 is Mr. Anthony's witness.

8 MR. SCOTT: I presume that  
9 he has. In the event that he hasn't I will do my  
10 best to get it to him first thing on Monday morning  
11 and indeed if possible we might begin with the  
12 Witness Parker first if Mr. Weedon wants some  
13 time to examine that transcript.





1 THE COMMISSIONER: You can see  
2 if someone will phone Mr. Anthony today and make sure that  
3 Weedon did get that transcript, because Dr. Banfield  
4 was, I thought, very critical, to put it mildly.

5 MR. SCOTT: Messrs. Weedon and  
6 Parker then will be the first two witnesses to be  
7 cross-examined by all. Mr. Owen-Hughes will be the  
8 third witness to be cross-examined by all persons.

9 THE COMMISSIONER: Would you  
10 mind reminding me what his evidence was about?

11 MR. SCOTT: Well, as I wasn't  
12 at Whitehorse on that occasion --

13 THE COMMISSIONER: That was  
14 the --

15 MR. SCOTT: He was the govern-  
16 ment servant. He was called by Mr. Anthony also, though  
17 a government servant, and he gave evidence on terrain  
18 typing.

19 THE COMMISSIONER: Oh yes,  
20 I remember that.

21 MR. SCOTT: And it may be that  
22 other participants may have some questions to ask him.  
23 We certainly will. So he will be the third witness.  
24 Then Mr. Anthony has given notice that he intends to  
25 call two other witnesses on the alternative corridors  
26 issue -- Messrs. Rutter and Rowed, and they will be  
27 called fourth and fifth, examined in chief and cross-  
28 examined. The only difficulty about time there is  
29 that Mr. Rowed will not be here until Thursday morning.

30 THE COMMISSIONER: What corridor



1 will they be talking about, the Fairbanks corridor  
2 or the --

3 MR. GENEST: Franklin, I  
4 think it's east of Franklin.

5 MR. SCOTT: It's the edge of  
6 the shield and east of the Franklin.

7 MR. GENEST: Under Great Bear.

8 MR. SCOTT: Then I would  
9 propose that we, if Mr. Williams is around, that we  
10 might cross-examine him on what he has said today,  
11 and then we would conduct the examination in chief of  
12 panel 1 in Phase 2 and 3. I have arranged, and I think  
13 all counsel agree to this, that in order to avoid  
14 bringing all the members of that panel who would not  
15 normally be cross-examined next week, that it will be  
16 useful to bring only one or two persons who can speak  
17 generally to all the issues and read the evidence,  
18 it being understood that at the time of cross-examination  
19 the appropriate persons in each of the ~~tree~~ disciplines  
20 or in each of the three areas covered by the first panel  
21 will be available to be cross-examined.

22 I remind counsel, for what  
23 it's worth, that the proposal with respect to cross-  
24 examination of this panel is that cross-examination  
25 of the panel be divided into three parts:

- 26 1. A complete cross-examination as to terrain issues.  
27 2. A complete cross-examination as to water resources.  
28 3. A complete cross-examination of air quality.

29 That will make it possible  
30 for Mr. Genest to have some leeway in bringing the



1 appropriate people here and will, I think, make it  
2 easier to absorb the impact of the evidence-in-chief  
3 and the cross-examination.

4 MR. GENEST: Sir, what that  
5 overlooks that Mr. Scott has -- we're quite prepared  
6 to do that. I am not as optimistic on time as he is.  
7 For instance, this week I would have thought our own  
8 estimates that our geotechnical people would be on a  
9 Tuesday afternoon, and then I assume the cross-examina-  
10 tion of Mr. Longlitz and Dr. Lewis and Dr. Adam.

11 There is the issue of the  
12 corridor phase of any rebuttal evidence, as to witnesses  
13 brought forward by CARC and any other party; but we  
14 really can't make any decision on it until our  
15 cross-examinations have been completed.

16 There's an outstanding issue  
17 that was raised by Mr. Gibbs at Whitehorse as to seg-  
18 mented line costs which has to be dealt with. Now I  
19 don't know if --

20 THE COMMISSIONER: The compar-  
21 ison of Fairbanks and Mackenzie Valley.

22 MR. GENEST: That's right.

23 MR. SCOTT: Those two issues  
24 obviously require to be dealt with during the week.  
25 There is the possibility that Mr. Gibbs will be asked  
26 either to make a statement or perhaps to lead a witness,  
27 I don't know, it will be up to him, as to his position  
28 with respect to alternative corridors for Foothills  
29 application. I'm judging at the moment that whatever  
30 course he adopts he isn't likely to take up too much



1 time, and I would have thought that it would be possi-  
2 ble to finish this work in the week. We have one  
3 community hearing, I think, on Wednesday of next week,  
4 and I would hope that if necessary we could, when we  
5 see how we're proceeding, we could sit an hour or two  
6 in the afternoons, or as may be required, so that a  
7 real effort is made to finish this, so that when we  
8 begin the next session we will be square into Phase 2  
9 and 3.

10 Now the one rider on that is  
11 the problems that Mr. Genest and Mr. Gibbs may have  
12 about rebuttal evidence, and I would simply suggest that  
13 that should be left to be dealt with. As someone said  
14 earlier, we'll jump off that bridge when we come to it.

15 MR. GIBBS: Well, on the  
16 question of the financial evidence that Arctic Gas  
17 were to produce, sir, following the Whitehorse hearing,  
18 we can't very well deal with that next week until we  
19 get the financial material.

20 MR. SCOTT: That's right.

21 THE COMMISSIONER: I don't  
22 think it's financial. I think Mr. Scott wants you to  
23 indicate at some stage where you sit on this FAirbanks  
24 thing.

25 MR. SCOTT: M r. Gibbs, I  
26 think, is talking about the other.

27 MR. GIBBS: Yes, there are two  
28 issues. That was the first one and I was just reminding  
29 Mr. Scott that we can't deal with those financial  
30 comparisons until I get the financial material that







1 Arctic Gas was to produce.

2 MR. GENEST: That should be  
3 ready, I understand, early next week, so I agree with  
4 Mr. Gibbs, he can't very well be expected to take a  
5 stand until he sees what we produce.

6 MR. GIBBS: With reference to  
7 the alternate corridors, Mr. Commissioner, we will be  
8 making a statement and not calling a witness.

9 THE COMMISSIONER: One other  
10 thing, Mr. Scott, Commissioner Parker and Dr. Weedon  
11 from Alaska are not subject to the Inquiry's writ or  
12 subpoena. They appeared in Whitehorse and are  
13 appearing here Monday as a matter of courtesy to the  
14 Inquiry, and to Canada, I suppose. I'd like you  
15 to make sure we tailor the hearing to their convenience.  
16 So if they want to sit Tuesday evening, we should  
17 accommodate them -- no, not Tuesday, Monday evening.  
18 If they are the first witnesses Monday afternoon,  
19 then we should carry right on Monday evening, as we  
20 usually do, to accommodate them. I'd just like you  
21 to make sure that we let them get away on the plane  
22 they want to get away on as fast as possible, because  
23 they are really --

24 MR. SCOTT: Well, I think, my  
25 present estimate is that it's unlikely that we would  
26 finish both of them on Monday. I think we can  
27 negotiate to see who wants to go first and that sort  
28 of thing; but I would propose that in order to get  
29 through all this work we will have to move, using  
30 every available moment next week.



1 THE COMMISSIONER: Well, let's  
2 -- we have a weekend now to recuperate, so let's begin  
3 to think in terms of sitting during the evenings next  
4 week, wherever that is necessary. Monday evening  
5 certainly, and we'll be Wednesday evening at Latham  
6 Island, so we might even have to consider sitting  
7 Tuesday evening and perhaps Thursday evening as well,  
8 just to make sure we wind up all of that work next  
9 week, because then we have another week to recuperate.

10 MR. SCOTT: Yes.

11 Two other matters, I would  
12 like, if there is any time next week, to have a meeting  
13 of counsel to discuss a number of matters. I was  
14 thinking perhaps Tuesday. Mr. Marshall always provides  
15 the refreshments, and perhaps he could be induced to  
16 do that at the break Tuesday evening.

17 With that in mind I would  
18 like to have before Tuesday the responses of the  
19 various counsel to the survey that we circulated as  
20 to their estimates of time.

21 We've heard from Mr. Bayly.  
22 We've filed our own response. I don't think we've  
23 heard from anybody else and I'd be grateful, particularly  
24 if the two applicants could let us have their estimates,  
25 no matter how rough, on or before Tuesday.

26 The last matter relates to the  
27 index. As a result of what Mr. Marshall said, our  
28 loyal indexers are offended and in revolt. He said that  
29 he couldn't find any --

30 MR. GENEST: He's on a frolic



1 of his own.

2 MR. SCOTT: He said that he  
3 couldn't find any 'index, any references to horrendous,  
4 to frost heave, or to thaw settlement.

5 As far as horrendous is  
6 concerned, it is not indexed. Nothing is indexed under  
7 "horrendous", perhaps because it's an adjective that  
8 applies to most of what we've heard.

9 With respect to frost heave,  
10 he can find that if he looks at the index to the index,  
11 and he will find that frost heave, you're referred to  
12 pipeline frost or pipeline frost heave.

13 If he's looking for thaw  
14 settlement, if he looks under "settlement" he will  
15 find only a reference to native land claims, but if  
16 he looks under "differential settlement", which is the  
17 context in which most of the settlement questions have  
18 been discussed, he will find adequate reference to the  
19 index.

20 I take it that this is not  
21 an expression of any intention of his not to pay for  
22 the index, and we look forward to seeing that that's  
23 done from time to time.

24 MR. GENEST: Tuesday night.  
25 In kind.

26 THE COMMISSIONER: Well,  
27 there's just one other matter. In keeping with the  
28 Inquiry's policy of ensuring that the participants  
29 are advised of things they are entitled to know about,  
30 I should place it on the record that at my request



1 Dr. Fyles, who heads our Inquiry Appraisal Team, and Dr. Morgan  
2 to the Soviet Union with a delegation from Canada in  
3 September, returning in October, and they visited the  
4 Gas Ministry in Moscow and spent something like two  
5 weeks visiting gas -- the gas pipelining system in the  
6 Soviet Union, and in some way, that I leave to Commis-  
7 sion counsel, their views and opinions will be disclosed  
8 to the Inquiry.

9 MR. SCOTT: One other matter,  
10 Mr. Commissioner, if you're finished that, is as we  
11 near the end of Phase 1, we wrote to all of the  
12 participants asking them if there were any members of  
13 the Assessment Group<sup>who</sup> participated in the preparation of  
14 the PAG Report, whose evidence with respect to Phase 1  
15 matters they required us to lead, and we have now  
16 completely responded to those requests, and I regard  
17 our duty there discharged.

18 THE COMMISSIONER: All right.  
19 Well, we'll adjourn then until Monday. I take it one  
20 o'clock Monday is satisfactory, is that all right  
21 with you, Mr. Gibbs and Mr. Genest?

22 MR. GENEST: Sir, I will not  
23 be here next week. I have another matter. Mr. Marshall  
24 will and I take it he is used to getting up at four  
25 in the morning to catch the plane to Edmonton, so I'll  
26 tell him that's the hour.

27 MR. GIBBS: Yes, I'll be making  
28 my agreement on behalf of Mr. Hollingworth, who will  
29 be the same early rise.  
30







1 MR. SCOTT: Obviously we'll  
2 proceed with more despatch next week than we have this  
3 week, under those 'circumstances.

4 THE COMMISSIONER: O.K., well  
5 we'll adjourn to one o'clock Monday.

6 MR. GENEST: I just wanted  
7 the last thing on the record is my strong objection  
8 to Mr. Scott's last statement, so we can't end on  
9 sweetness and light.

10 (PROCEEDINGS ADJOURNED TO OCTOBER 20, 1975)  
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AUTHOR

Mackenzie Valley pipeline inquiry:

Vol. 74      17 October 1975

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CHITSEK

MACKENZIE VALLEY PIPELINE INQUIRY

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Publications

IN THE MATTER OF APPLICATIONS BY EACH OF

- (a) CANADIAN ARCTIC GAS PIPELINE LIMITED FOR A  
RIGHT-OF-WAY THAT MIGHT BE GRANTED ACROSS  
CROWN LANDS WITHIN THE YUKON TERRITORY AND  
THE NORTHWEST TERRITORIES, and
- (b) FOOTHILLS PIPE LINES LTD. FOR A RIGHT-OF-WAY  
THAT MIGHT BE GRANTED ACROSS CROWN LANDS  
WITHIN THE NORTHWEST TERRITORIES,

FOR THE PURPOSE OF A PROPOSED MACKENZIE VALLEY PIPELINE

and

IN THE MATTER OF THE SOCIAL, ENVIRONMENTAL AND  
ECONOMIC IMPACT REGIONALLY OF THE CONSTRUCTION,  
OPERATION AND SUBSEQUENT ABANDONMENT OF THE ABOVE  
PROPOSED PIPELINE

(Before the Honourable Mr. Justice Berger, Commissioner)

Yellowknife, N.W.T.,

October 20, 1975.

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PROCEEDINGS AT INQUIRY

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I N D E X

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WITNESSES FOR CANADIAN ARCTIC RESOURCES COMMITTEE:

Robert WEEDON

Walt PARKER

- In Chief (cont'd) 11025

- Cross-Examination by Mr. Marshall 11032

EXHIBITS:

287 Cost comparison between Fairbanks Corridor  
& Prime Route 11141

347  
11025  
11032

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APPEARANCES:

Mr. Ian G. Scott, Q.C.  
Mr. Stephen T. Goudge,  
Mr. Alick Ryder and  
Mr. Ian Roland for Mackenzie Valley  
Pipeline Inquiry;  
Mr. Pierre Genest, Q.C.  
Mr. Jack Marshall,  
Mr. Darryl Carter, and  
for Canadian Arctic Gas  
Pipeline Limited;  
Mr. Reginald Gibbs, Q.C.  
Mr. Alan Hollingworth for Foothills Pipelines  
Ltd.;  
Mr. Russell Anthony,  
Prof, Alastair Lucas for Canadian Arctic  
Resources Committee;  
Mr. Glen W. Bell and  
Mr. Gerry Sutton for Northwest Territories  
Indian Brotherhood and  
Metis Association of the  
Northwest Territories;  
Mr. John Bayly for Inuit Tapirisat of  
Canada and the  
committee for Original  
Peoples Entitlement;  
Mr. Ron Veale and  
Mr. Allen Lueck for the council for the  
Yukon Indians  
Mr. Carson H. Templeton for Environment Protect-  
ion Board;  
Mr. David Reesor for Northwest Territories  
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cipalities  
Mr. Murray Sigler for Northwest Territories  
Chamber of Commerce



Weedon & Parker  
In Chief

Yellowknife, N.W.T.,

October 20, 1975.

(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

THE COMMISSIONER: Well, are  
we ready to go?

MR. SCOTT: Ready, Mr.  
Commissioner, and it looks like Whitehorse because  
our Whitehorse panel is back today.

MR. ANTHONY: Mr. Commissioner,  
I believe that we were to continue on with the alter-  
nate route evidence, and you see before you Mr. Parker,  
the Commissioner of Highways, and Dr. Weedon, the Dir-  
ector of Planning & Policy of the Governor's Office,  
and they are here now to proceed with cross-examination.  
You listened to their evidence at Whitehorse.

Before turning them over to  
my friends' questioning, as they left Whitehorse --  
and this is found in Volume 54 of the transcript,  
page 7585, there were some questions about snow roads  
put to Mr. Parker by Mr. Marshall, and Mr. Marshall  
provided the Northern Engineering Services Snow Roads  
Report to the State of Alaska officials, and I indicated  
at that time that they may wish to make some comment  
on the general question, and on those reports in  
particular.

ROBERT WEEDON,  
WALT PARKER, resumed:

DIRECT EXAMINATION BY MR. ANTHONY (CONTINUED):

Q I was wondering if Mr.



Weedon & Parker  
In Chief

1 Parker would perhaps start by making those comments  
2 and indicating the Alaska experience with snow roads,  
3 and then going onto a comment about the Northern  
4 Engineering Services Reports that Mr. Marshall provided?

5 THE COMMISSIONER: Go ahead  
6 Commissioner Parker, if you would.

7 WITNESS PARKER: Yes. The  
8 Department did review the Northern Snow Roads Report  
9 and having had no opportunity to observe the experiment  
10 on the ground, we are un-able to comment at any great  
11 length upon it. I guess our attitude at the moment  
12 would be operationally not proven, and as the application  
13 of the test results to an operational situation, and  
14 excepting the construction methods used, why without  
15 more testing in an operational sense as to the ability  
16 of roads to stand up to continual use of heavy equipment,  
17 and such things, why we really can't say whether they  
18 really will work and do the job as proposed, providing  
19 they can be built.

20 THE COMMISSIONER: That's your  
21 observation on the Arctic Gas Report on its snow road  
22 test in Inuvik?

23 A Yes.

24 Q Yes, right.

25 A The point on the continual  
26 use of heavy equipment is, we believe, an important  
27 one, which requires further investigation, and that's  
28 based upon our recent experience with the Arctic haul  
29 road that is being used to build the Alyeska Pipeline.  
30 We have had problems in maintaining the road with the



Weedon & Parker  
In Chief

1 continued use of heavy equipment, and we are certainly  
2 going to be looking further into this.

3                   Regarding the general history  
4 of the use of snow roads in Alaska, it begins back with  
5 the original use of cat train, in other words, sleds  
6 pulled by caterpillar tractors or other tracked vehicles  
7 during World War II, and these did not in essence use  
8 snow roads. All they did was take off across-country,  
9 clear the timber out of their path, and there was no  
10 particular attempt made to protect the overlying vege-  
11 tation, and of course there was some damage due to  
12 that, and of course Alaska is criss-crossed with these  
13 roads, but these are not snow roads in the sense which  
14 we are considering here.

15                   In the initial stages of the  
16 development of the Prudhoe field, an attempt was made  
17 to build an ice road to the Arctic Slope, and in this  
18 case the road was prepared for use by trucks and it was  
19 in effect the over-burden was bladed aside and an ice  
20 road was created either frozen ground or ice, depending  
21 upon the surface, and this did not prove to be a  
22 successful experiment. Very little traffic was moved  
23 over it and we continued to rely primarily upon Hercules  
24 aircraft and barges for the development of the Prudhoe  
25 field until the road which accompanies the pipeline  
26 was completed in the fall of 1974.

27                   We have no experience with  
28 moving large amounts of freight over snow roads similar  
29 to those proposed in the Gas Arctic proposal, and there  
30 have been, to my knowledge, no serious efforts to really







Weedon & Parker  
In Chief

1 construct a road in that manner.

2 During the Dew Line days,  
3 in the period from 1950 to 1957 there was a good deal  
4 of movement of traffic over land, but this, in this  
5 case the vehicles were adapted to the terrain, some  
6 special vehicles were built, and also there was a great  
7 deal of use of the same techniques in World War II.



As I said, both the federal and state offices made a strong effort to get as much snow work paid incorporated into the design as possible. Thus far we have used an alternative



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11030

1 means which is a thin work pad for winter construction  
2 which is essentially 18" of gravel and, put on during  
3 the winter, and then they heavy equipment is mobilized  
4 when the ground stability is as firm as possible and  
5 got out of there well before any thawing action  
6 occurs, and that limits you to about ten to twelve  
7 weeks to get your heavy equipment in and out.

8 The thin work pads can then be utilized for lighter  
9 weight equipment as seasonal conditions permit.

10 We have used -- the thin work pad has been a success  
11 in some areas and not in areas. In some areas the  
12 initial 18" is not enough and it had to be built  
13 up to three feet to do the job. In other areas  
14 18" did prove satisfactory. The spreads, the  
15 construction crews moved in, did their job, moved  
16 out and left the work pad and the gravel savings were  
17 achieved. I have had no opportunity to observe  
18 thin work pad construction on the Arctic slope as  
19 yet. I haven't been able to observe it south of  
20 the Brooks Range, and south of the Alaska Range and  
21 generally it has worked there as we hoped it would  
22 except in those areas where it was necessary to build  
23 it up due to the instability of the pad at 18".

24 We are, of course, monitoring this very carefully  
25 and will hopefully come out of this winter with a  
26 very good idea of where we can use minimal amounts  
27 of gravel and still not break down the tundra cover.  
28 What you have left, of course is 18" of gravel on  
29 top of the tundra and we are not sure yet what effect  
30 this is going to have in the final analysis. In the



1 areas I have observed I have not been displeased with  
2 the way in which the work pad is being resorbed into  
3 the tundra. However, we have no real knowledge yet  
4 as to whether this new thermal regime that has been  
5 imposed, whether it will act as a heat sink and  
6 cause thermokarsting or not eventually. It could,  
7 but that was the chance we took in order to save  
8 as much gravel as possible and we of course don't  
9 believe that it is going to be serious or we wouldn't  
10 have approved the procedure in the first place.

11 MR. ANTHONY: Thank you.

12 Now, would you gentlemen answer any questions that  
13 other counsel may have?

14 MR. MARSHALL: Mr. Commissioner,  
15 I believe when we were in Whitehorse I had begun  
16 the cross-examination of the panel and I propose to  
17 continue even though it is out of the usual order.  
18 Perhaps before I do I should mention, sir, that Mr.  
19 Gibbs had requested of Mr. Dau a certain breakdown  
20 of cost information --

21 THE COMMISSIONER: Relating  
22 to the Fairbanks route.

23 MR. MARSHALL: Yes, sir,  
24 and Mr. Dau has prepared such material. I have  
25 had it delivered to Mr. Gibbs in Calgary this morning.  
26 I have brought additional copies for counsel. I have  
27 distributed them to those who were here early. I  
28 think I have missed Mr. Bayly and Mr. Bell, and I  
29 think Mr. Templeton is not here today. I have  
30 these available and I will give them out.





Parker, Weedon  
Cross-Exam by Marshall

THE COMMISSIONER: All right.

CROSS-EXAMINATION BY MR. MARSHALL (continued):

Q Mr. Parker, if we could just begin with the evidence that you have just given today. You made reference to the Alyeska haul road. That, sir, is not a snow road according to the definition that is being used by Northern Engineering?

A No, the Alyeska haul road is constructed to the State of Alaska and the United States Secondary Highway Standards.



Weedon & Parker  
Cross-Exam by Marshall

1 Q Now, sir, the other  
2 example that you were giving related to -- firstly  
3 to the paths cut by the cat trains, and that was really  
4 no snow road at all, I take it it was just the cats  
5 cutting a path through the forested areas.

6 A That's correct.

7 Q You also mentioned an  
8 ice road to the Arctic Slope. Do I take it this would  
9 be the so-called Hickle Highway?

10 A Yes sir.

11 Q And as I understand it,  
12 that wasn't a snow road or an ice road as such, it's  
13 more what we call here, in Canada, a winter road, such as  
14 is used in winter construction areas, say in Alberta.

15 A Yes, that's correct.

16 Q So neither of those  
17 examples then really would be snow roads.

18 A Right.

19 Q Now sir, I was wondering  
20 whether your experience of the use of snow roads would  
21 extend to the use of such snow roads in the Mackenzie  
22 Delta in recent years by oil and gas exploration  
23 companies?

24 A No, we have never had an  
25 opportunity to observe the snow roads in the Mackenzie  
26 Delta. To the best of my knowledge, why no one in  
27 State Government at this time has had that opportunity, if  
28 so they have not come forward.

29 Q Sir, I listened with  
30 interest to your description of the thin work pads that



Weedon & Parker  
Cross-Exam by Marshall

1 Alyeska has been using, and I was wondering, sir,  
2 whether or not use of these thin work pads was under-  
3 taken without any operational proving or testing?

4 A No. There was testing  
5 of the thin work pads at the Fairbanks site, and it  
6 was based on those tests that we went forward with the  
7 thin work pad approval.

8 Q Thank you, sir. Dr.  
9 Weedon, I have some questions for you, sir. Would you  
10 have before you Volume 54 of the transcript of the  
11 proceedings of the Inquiry?

12 WITNESS WEEDON: I do not.  
13 I have my transcript of my own testimony.

14 Q Fine, that's what we  
15 will be dealing with, sir.

16 THE COMMISSIONER: Are the  
17 pages numbered?

18 A Yes, they are.

19 THE COMMISSIONER: Oh, fine.  
20 We'll be able to carry on.

21 A Mr. Marshall, my direct  
22 examination by Mr. Anthony is on my page No. 7449, is  
23 that going to be consistent with your numbering?

24 MR. MARSHALL: Yes. I take it  
25 you have a photo copy of the transcript?

26 A That's correct.

27 Q Fine, sir. We're able  
28 to proceed. All right, the first thing I wanted to  
29 get into with you, sir, was pertaining to your pro-  
30 fessional experience that related specifically to the



Weedon & Parker  
Cross-Exam by Marshall

1 North Slope in Alaska, and especially the proposed  
2 route that would be followed by Alaskan Arctic Gas.

3 THE COMMISSIONER: Excuse me,  
4 Mr. Marshall.

5 MR. MARSHALL: Yes sir.

6 THE COMMISSIONER: Just to  
7 re-orient myself, when you gave evidence before the  
8 Inquiry in Whitehorse, Dr. Weedon, you said that you  
9 favored the Prudhoe Bay gas being taken out via north-  
10 south route, and you were opposed to the notion of a  
11 gas pipeline such as Arctic Gas proposes taking Prudhoe  
12 Bay gas along the North Slope of Alaska to the  
13 Canadian border. That was essentially your position?

14 A Yes, that's the position  
15 of the state.

16 Q And it's one to which you sub--  
17 scribe without reservation, I take it?

18 A Yes.

19 MR. MARSHALL: Q Sir, I was  
20 wondering if you could tell us about the professional  
21 work that you as an environmentalist have undertaken  
22 that pertains specifically to the North Slope area of  
23 Alaska with which we're concerned?

24 A I have done none with  
25 the exception of a short piece of work, approximately  
26 two weeks in duration, in the summer of 1960 on the  
27 Prudhoe Bay-Colville River delta area, and it was done  
28 on waterfowl, specifically black brandt.

29 Q And that's the extent of  
30 your work in this region?





Weedon & Parker  
Cross-Exam by Marshall

A      That's correct.

Q Sir, on page 7456 of the transcript you deal with various environmental criteria, and near the bottom of the page you speak of:

"Our most critical concerns, our judgments," and so on, and a familiarity with the Alaskan portions of the proposed routes. Now sir, I was wondering who it was that you were including within this term "our"? I take it that that included yourself.

A        Yes. It is a somewhat global term, and I am here to represent the State of Alaska, and what I have said here is first of all an accurate statement of the summary position of the State of Alaska.        I am reflecting my conversations with quite a large variety of biologists and environmental scientists of various sorts. So that in this particular case when I say, "our judgments are", I refer to the judgment of people other than myself, as well as myself.

MR. MARSHALL: Mr. Commissioner and Mr. Anthony, the witness' answer causes me some difficulty in the sense that I'm not really sure whose opinions we're dealing with. Dr. Weedon indicates that the opinion expressed is that of the State of Alaska, and he's talked to a number of individuals and so on. I want to cross-examine in some detail about the opinions expressed. Am I to take it that Dr. Weedon cannot speak to these various matters? They don't represent his, that he's simply a spokes-person or other unnamed individuals? Perhaps Mr. Anthony can help



Weedon & Parker  
Cross-Exam by Marshall

1 me on that.

2 MR. ANTHONY: I would suggest  
3 that really Dr. Weedon is here, obviously, as head of  
4 a Department in the State of Alaska that has studied  
5 it, and he's obviously relying on the views and opinions  
6 of a large number of various environmental consultants,  
7 as much as I'm sure Mr. Dau gave evidence relying on  
8 Northern Engineering, and Mr. Horte gave evidence  
9 relying on Northern Engineering. I think that if he  
10 has any -- the position he's expressed is that of a  
11 Department that he heads within the State of Alaska,  
12 and as he says, also an opinion he subscribes to, if  
13 there's any distinction between the two I would expect  
14 he would make that clear.  
15  
16  
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18  
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1 MR. SCOTT: Mr. Commissioner,  
2 I wouldn't have thought the question posed any  
3 particular problem. If these opinions are shared by  
4 Dr. Weedon, no doubt he can be cross-examined on them.  
5 If the opinion expressed isn't one that he shares,  
6 he will no doubt say so and that will be the end of  
7 that matter.

8 MR. MARSHALL: Well, I am  
9 prepared to proceed, sir, I have some questions  
10 that I intend to follow, to develop this more fully  
11 and we can just carry on and see where it gets us.

12 Q I was wondering, sir,  
13 if you could tell me then who the various individuals  
14 were who were involved and what disciplines were  
15 represented by those individuals and what their  
16 particular fields of expertise were that relate to  
17 the subject of your address.

18 A There are both federal  
19 and state personnel involved and I might refer you  
20 to the Bureau of Land Management Report which I  
21 have tabled. I am sorry. I guess this report was  
22 tabled prior to my coming on the scene. Counsel, do  
23 you have a reference for the Bureau of Land Management's  
24 Environmental Impact Statement?

25 MR. ANTHONY: I believe that  
26 the one volume of the statement was used by me in  
27 cross-examination. I am afraid that I don't have the  
28 exhibit number, but I can locate that for Mr.  
29 Marshall if he wishes.  
30

A What I was going to say



1 THE COMMISSIONER: Excuse  
2 me just a moment. Maybe we could dig it out right now.

3 A It is part II, Volume I  
4 is the main one that I use as a reference. I  
5 refer to that simply because in many of those instances  
6 where I make particular factual statements or summary  
7 statements I am referring, using as a reference,  
8 all of those people expert in various environmental  
9 areas that undertook the studies for the Federal  
10 Government, for the Bureau of Land Management. I  
11 am sorry that I cannot personally list them all,  
12 but they are there as participants in the study.

13 In addition to that the  
14 State of Alaska has over the years, certainly pre-  
15 dating the discovery of oil in Prudhoe Bay and post-  
16 dating that discovery, has conducted quite a considerable  
17 amount of research on various wildlife species in  
18 Northern Alaska. This experience is reported in  
19 numerous reports, many of which are cited in that  
20 Bureau of Land Management Impact Statement, and it  
21 is that body of data and in fact those very personnel  
22 whose judgments have been passed on to the Commissioner  
23 of Fish and Game, Commissioner James Brooks, whose  
24 testimony and participation in our State of Alaska's  
25 working towards a position on this matter have been  
26 critical in giving us the input on fishery and wild-  
27 life matters.

28 MR. MARSHALL: It is not  
29 clear to me which report the witness is referring  
30 to. Is it the blue document that is entitled





Parker, Weedon  
Cross-Exam by Marshall

1 Alaska Natural Gas Transportation System Draft,  
2 Environmental Impact Statement?

3 A I believe that is  
4 correct, yes.

5 Q That is the United  
6 States Department of the Interior?

7 A That is correct.

8 Q Not the Bureau of  
9 Land Management?

10 A The Bureau of Land  
11 Management is a portion of the Department of the  
12 Interior. It is a bureau within the department, it  
13 was responsible for preparing that impact statement.

14 Mr. Commissioner, and Mr.  
15 Marshall, the Gas Pipeline Study Group is a specific  
16 group within the Department of the Interior that --  
17 but that is a temporary and ad hoc group that was  
18 put together for the purpose of doing this draft  
19 environmental impact statement.

20 Q Well, I take it then,  
21 Dr. Weedon, what you are saying is that that report  
22 is one of the documents on which you rely in support  
23 of your evidence.

24 A That is correct.

25 Q I imagine that during  
26 the course of our discussion this afternoon we will  
27 get to more specific aspects of that as they apply  
28 to the various subjects that are encompassed.

29 Now, sir, you made specific  
30 reference to the draft Environmental Impact Statement.



Parker, Weedon  
Cross-Exam by Marshall

1 You made general refernce to work that has been done  
2 by State agencies in Alaska. Can you be more  
3 specific than that as to which materials it is that  
4 you are relying upon and have relied upon in support  
5 of the statement that you have given?

6 A The State of Alaska  
7 with the change of administration in December of  
8 this last year put together a task force or study  
9 group headed by Commissioner, or Attorney General,  
10 Avrum Gross who is the Attorney General and head  
11 of the Department of Law in the State of Alaska. That  
12 study group or task force is comprised of a number  
13 of commissioners, each of whom then is an executive  
14 head of a departm-ent of the government, with an  
15 interest in this gas pipeline question and the  
16 commissioners involved, or heads of -- executive heads  
17 of departments are Commissioner James Brooks of  
18 Fish and Game, Commissioner Ernst Mueller, M.U.F.L.L.E.R.,  
19 of the Department of Environmental Conservation,  
20 Commissioner Parker who has testified here on behalf  
21 of the Department of Highways, Commissioner Donald  
22 Harris, head of the Department of Public Works, Commis-  
23 sioner Guy Martin as the head of the Department of  
24 Natural Resources. Have I left any out, Walt? Yes,  
25 Commissioner Motley, the head of the Department of  
26 Commerce and Economic Development. That is M.O.T.L.E.Y.

27 Now, that task group has been  
28 preparing for testimony as intervenor in the Federal  
29 Power Commission case, and they have pulled together  
30 quite an extensive list of documents on which they and



Parker, Weedon  
Cross-Exam by Marshall

1 I have relied for, for this testimony and more  
2 particularly for our testimony before the Federal  
3 Power Commission in Washington, D.C.

4 THE COMMISSIONER: In that  
5 report, that was a report prepared for Governor  
6 Hammond, as I recall.

7 A That is correct.

8 THE COMMISSIONER: Because  
9 upon his taking office he wanted to take a fresh look  
10 at the El Paso project and the Arctic Gas project,  
11 and as I recall the report from the Attorney General  
12 indicates that the group was somewhat unimpressed with  
13 both the El Paso and the Arctic Gas Projects, is  
14 that a fair summary of the way they looked at them?

15 A In terms of the amount  
16 of detailed and factual data on which we could  
17 go on a mile by mile analysis of the proposed routing,  
18 yes.



Weedon & Parker  
Cross-Exam by Marshall

1 Q Sir, in the early part  
2 of your direct evidence you filed a number of exhibits  
3 of the State of Alaska, and I believe you described them  
4 as outlining to the best of your current knowledge the  
5 existing situation in the Alaskan Arctic, with respect  
6 to both natural factors and development factors. Now  
7 again sir, when you were speaking of -- I think your  
8 phrase was, "our current knowledge", you were referring  
9 to yourself, were you, sir, or your department, or  
10 just exactly what was it?

11 A I'm trying to find the ref-  
12 erence to "our current knowledge".

13 Q You might look at 7458  
14 at the bottom of the page, line 30. You say, and I  
15 quote:

16 "It's replete with both text and statistical and  
17 illustrative material, both photographs and  
18 maps which outline to the best of our current  
19 knowledge the existing situation in the Alaskan  
20 Arctic with respect to..."  
21 and it goes on.

22 A The "our" in that case  
23 includes me, as well as other state officials.  
24 I am talking here about an outline, and a summary,  
25 not necessarily all of the up-to-the-minute details.  
26 Obviously these change minute by minute.

27 Q But to deal with your  
28 knowledge, sir, does that include a knowledge of the work  
29 which has been done by Arctic Gas?

30 A Which work are you referring







Weedon & Parker  
C ross-Exam by Marshall

1 to specifically?

2 Q Well, to begin with,  
3 the work that's been published in the Biological  
4 Report series.

5 A I have only looked through  
6 that casually because it's in far too much detail for  
7 me to have said that I could study it.

8 I might add here that it's  
9 precisely because of the vast amount of detail and  
10 the rapidity with which new knowledge is being achieved  
11 that we have to have -- we have to rely on a large  
12 number of people to keep abreast in different areas  
13 rather than having one person the font of all knowledge,  
14 and I'm sure that this will be borne out in the number  
15 of witnesses that attend the Federal Power Commission  
16 hearings.

17 WITNESS PARKER: Mr. Commiss-  
18 ioner?

19 THE COMMISSIONER: Yes sir?

20 A Could I add something  
21 to that?

22 Q Yes.

23 A The Gas Arctic material  
24 which is furnished us on an on-going basis is under  
25 constant review by the Department of Highways regarding  
26 their aspects by the Departmen t of Fish & Game, and  
27 by the State Pipeline Office, each in its own particular  
28 area of expertise, so the information is being  
29 thoroughly reviewed. I'm sure that the very excel-  
30 lent biological documents have been gone over and



Weedon & Parker  
Cross-Exam by Marshall

1 over by the Department of Fish & Game.

2 MR. MARSHALL: Well, unfortun-  
3 ately we don't have all the Department available for  
4 cross-examination. We do have this --

5 THE COMMISSIONER: This isn't  
6 getting us anywhere. Of course we don't have the whole  
7 Department available. We have Commissioner Parker  
8 and Dr. Weedon as a matter of courtesy, they have  
9 agreed to come. But they are telling you what the  
10 position of the State of Alaska is. The State of  
11 Alaska is opposed to the Arctic Gas line running  
12 from Prudhoe Bay and across the North Slope to the  
13 Canadian border. Now that much is clear, and it seems  
14 to me there's no point in trying to wean them away  
15 from that position, and can't we go on to the specific  
16 matters you want to raise?

17 MR. MARSHALL: Well, sir, I  
18 suppose you've put your finger on the nub of the whole  
19 question. If it's clearly recognized that the  
20 evidence that's been put forward by the witnesses of  
21 the State of Alaska is an advocacy document, is a  
22 position paper of the State for which there is a  
23 collective concensus among the Governor and his staff,  
24 if this is the position of the state and its accepted  
25 by the Commission as being simply that, I'm quite  
26 content to leave it completely and not cross-examine  
27 on it at all.

28 But if it's being put forward  
29 as representing an environmental assessment of those  
30 matters that it purports to access on the basis of the



Weedon & Parker  
CrossExam by Marshall

1 various environmental disciplines, then I feel I must  
2 pursue it.

3 THE COMMISSIONER: Well, I think  
4 you should. They didn't flip a coin in the air and  
5 decide, "Well, if it comes up heads we'll be with  
6 Arctic Gas; tails we'll go for El Paso." They assessed  
7 it and then they came to this conclusion.

8 MR. MARSHALL: Well, sir, that's--

9 THE COMMISSIONER: I treat it  
10 on that footing.

11 MR. MARSHALL: Well, sir, --

12 THE COMMISSIONER: Having come  
13 to that conclusion, they're prepared to defend it.  
14 That's advocacy.

15 MR. MARSHALL: Well, sir, but  
16 Dr. Weedon has told me he hasn't read the material.  
17 He hasn't read the Arctic Gas Biological Report series,  
18 there are a number of them that pertain particularly  
19 and specifically to Alaska. I'm dealing with a  
20 shadow, if you like, sir. I'm told that somewhere  
21 within the collective wisdom of the state these things  
22 have been looked at. I'm anxious to be able to  
23 cross-examine people whose opinions are represented  
24 by the statements that have been made in the evidence.  
25 Now if it's simply a political statement advocating  
26 the State's position, fine, I'll leave it, I'm happy  
27 to leave it there, sir, if it's being accepted as  
28 being that.

29 MR. ANTHONY: Certainly the  
30 statement is of a collection of people, advisors to





Weedon & Parker  
Cross-Exam by Marshall

1 the Governor and advisors to the state officials.  
2 Now, the position as presented here -- I don't know  
3 what a political statement means -- but certainly the  
4 position that is presented here is a statement of the  
5 State based on consultants and a number of consultants,  
6 and a number of advisors. Now, just as we have asked  
7 Mr. Horte questions, and he's defended these questions  
8 on the basis of advice and reports that he's not  
9 read in detail, and we have accepted his views on all  
10 these points, I think in the same way Dr. Weedon and  
11 Mr. Parker are here to explain how they came to con-  
12 clusions and explain the research that's been done by  
13 their officials, not necessarily by themselves but by  
14 representatives of the state, and give the state's  
15 view. Now surely that's the way we've been proceeding  
16 for months.

17 THE COMMISSIONER: Well, of  
18 course it is. Here you've got Commissioner Parker,  
19 a man of great experience in the Department of Highways,  
20 and Dr. Weedon, a biologist. They happen to hold high  
21 office in the state. They rely upon their own know-  
22 ledge and experience as well as the knowledge and  
23 experience of others in making the statements they did  
24 last month or the month before in Whitehorse, and no  
25 doubt are prepared to defend them on the same basis.  
26 But don't say these are merely political statements as  
27 if they were on some kind of soap box.

28 MR. MARSHALL: I'm not saying  
29 that at all, sir. I apologize if I left that impression.  
30 I'm saying if that's what they are, fine, I needn't





Weedon & Parker  
Cross+Exam by Marshall

1 pursue it at all.

2 THE COMMISSIONER: I think you  
3 should pursue it, ask the questions you want to ask,  
4 and let's see how far we get. But it seems to be  
5 obvious to everyone in this room what the basis is  
6 upon which both of these gentlemen have agreed to  
7 appear, and they can't bring the whole department with  
8 them. Somebody has to keep working.

9 MR. MARSHALL: Well, sir, I'm  
10 happy to deal with the specifics, and I have a number  
11 of points.

12 Q Dr. Weedon, perhaps you  
13 could turn to page 7459 of the transcript, lines 24 to  
14 26 you say:

15 "...hence by using vegetation you can indicate  
16 an entire type of ecosystem with which you are  
17 dealing."

18 Have you found the reference, sir?

19 WITNESS WEEDON: Yes, I have.

20 Q Do I take that in your  
21 opinion, sir, you're suggesting that you can character-  
22 ize an entire ecosystem solely on the basis of vege-  
23 tation?

24 A You've gone a bit beyond  
25 what I have said here specifically. I have said,  
26 "...you can indicate an entire type of eco-  
27 system with which you are dealing."

28 And I will stand on that, yes. In fact there is a  
29 map to which I referred that I was tabling at that point  
30 which is called:



Weedon & Parker  
Cross-Exam by Marshall

1 "Major Ecosystems of Alaska,"  
2 and they use the simple fact that vegetation first of  
3 all is the basis for animal life, and secondly vege-  
4 tation is the way it is because of soil and climate  
5 factors, as well as historic factors of plant distri-  
6 bution, and thus you can use vegetation as an indicator  
7 of ecosystems of living things.

8 Q I guess I misinterpreted  
9 then. You say it's simply an indicator, not --

10 A That is correct.

11 Q -- any more.

12 WITNESS PARKER: Mr. Commissioner,  
13 Dr. Weedon is being too modest. Both he and I were  
14 heavily involved in the development of that particular  
15 map, and the principle which he enunciated here is  
16 well-accepted world-wide by the international biological  
17 program who funded the development of that map. I headed  
18 up the initial state effort at the university on that,  
19 and it was really Dr. Weedon's concept, along with  
20 Leslie Verick at the Northern Forest Research Laboratory,  
21 who is accepted world-wide as an expert on northern  
22 ecosystems, as is Dr. Weedon.



Parker, Weedon  
Cross-Exam by Marshall

1 I think, you know, we can  
2 argue that particular point some time, we would  
3 enjoy to.

4 Q Well, my advice  
5 is that there are a number of other factors, not  
6 merely vegetation that enter into it, such as  
7 competition amongst species, predation, human  
8 presence and various other factors.

9 WITNESS WEEDON:

10 A Correct, and I think I  
11 tried to be accurate in saying that the vegetation  
12 is an indicator of the kinds of these interactions  
13 going on.

14 Q Turning to page 7462 of your  
15 evidence you say at line three and following:

16 "Associated with this proposal is the establish-  
17 ment of new air and possible or probably  
18 road transportation in Alaska where none  
19 now exists."

20 Now, you are dealing with the Arctic Gas proposal?

21 THE COMMISSIONER: What page  
22 is that again?

23 MR. MARSHALL: 7462 sir.

24 A I am talking here about  
25 the Interior Route, so-called, one of the alternate  
26 proposals to the prime for Arctic Gas.

27 Q Well, that hadn't  
28 been clear to me, sir. Are you also, further down in  
29 that paragraph where you are dealing with the  
30 sentence:

"The location of the proposed pipeline corridor



Parker, Weedon  
Cross-Exam by Marshall

1 facilities could in turn lead to the devel-  
2 opment of oil and gas within the Arctic  
3 National Wildlife Range as well as the  
4 Beaufort Sea Offshore Province."

5 A Yes, correct.

6 Q That is a comment meant  
7 to apply only to the Interior Route?

8 A The statement which I  
9 made about the possibility of new air, road trans-  
10 portation systems would apply to the coastal route,  
11 the prime route, the interior route, in fact, all of  
12 those routes as proposed which do not utilize existing  
13 ground transportation facilities, either the Alaska  
14 Highway, or the existing North Slope haul road and  
15 the southerly road system of Alaska.

16 Q Dr. Weedon deal with  
17 the coastal or prime route. It is my information that  
18 the area has for sometime been a fairly well established  
19 air corridor, that there has been quite a bit of  
20 air traffic proceeding east and west along the  
21 coast. Are you aware of that?

22 A Yes, and particularly  
23 more or less recently, fairly major commercial flights  
24 going both to Prudhoe Bay and then along to Kaktovik  
25 on Barter Island.

26 Q And I gather there's  
27 also been air traffic along the coastal areas associated  
28 with the DEW line?

29 A Yes, and associated with  
30 much of the biological research going along there, that





1 is correct.

2 Q Now, sir, you speak  
3 about road transportation now. I wonder, sir, are  
4 you relating this to the coastal route as well that  
5 is proposed by Arctic Gas?

6 A Yes.

7 Q What road transportation  
8 do you have in mind, sir?

9 A Well, our judgment as  
10 mentioned by Commissioner Parker is that although  
11 Arctic Gas asserts that it can build a route across  
12 the Arctic Wildlife Range, a pipeline across the  
13 wildlife range in one year using only a snow or ice  
14 road, we have sincere doubts about that possibility  
15 and feel that there will be gravel used to build a  
16 more permanent road and that that is the basis of  
17 my judgment that you could be. The probability is  
18 there of -- in fact, with the construction of the  
19 pipeline you will also be building a more or less  
20 permanent road facility there, along either route.

21 Q Sir, is this an area  
22 that you are qualified in, or is this really an opinion,  
23 say, of Commissioner Parker, that you agreed with.

24 A The latter.

25 Q The latter.

26 You are a biologist,  
27 I understand.

28 A That is correct.

29 Q Now, sir, further on on  
30 the page you say, that page is 7462:



Parker, Weedon  
Cross-Exam by Marshall

1 "The location of the proposed pipeline corridor  
2 facilities could in turn lead to the devel-  
3 opment of oil and gas within the Arctic  
4 National Wildlife Range as well as the  
5 Beaufort Sea Offshore Province...."

6 The sentence goes on beyond that, but that is the  
7 part that I am interested in.

8 Again, sir, does the statement  
9 apply in your view to the coastal or prime route?

10 A Yes.

11 Q Now, sir, I was wondering  
12 if you had an opinion on this possibility. If the  
13 Arctic Gas Pipeline were not built along the coastal  
14 route, but if there were discoveries of oil and  
15 gas along the North Slope east of Prudhoe Bay, in  
16 your view, would pipelines for the transport be  
17 built or would they not be built?

18 A Would you ask the  
19 snapper of that question again?

20 Q Well, sir, you say  
21 that the location of the proposed pipeline could in  
22 turn lead to the development of oil and gas within  
23 the range.

24 A Yes.

25 Q If the pipeline weren't  
26 built along that area, but if there were oil and  
27 gas discovered in the range, would it be taken to  
28 markets in your view?

29 A It seems doubtful to  
30 me that oil and gas would be discovered in the range



Parker, Weedon  
Cross-Exam by Marshall

1 unless drilling were allowed in the range and drilling  
2 wouldn't be allowed within the range unless a classi-  
3 fication of the land were made that permitted such  
4 drilling, I would seriously doubt that if the  
5 area is still a wilderness after this position -- or  
6 this problem of the Arctic Gas application is  
7 settled, then I doubt that in fact a decision would  
8 be made to open up the Arctic Wildlife Range for  
9 exploratory drilling. So my basic point, and I am  
10 sure that you will recognize it, is that right now  
11 we have a wild area there which has yet the potential  
12 for becoming designated as a portion of the  
13 wilderness system with a capital "W", and I think  
14 I cited that a little farther along in the testimony.  
15 As long as there is not a pipeline laid through the  
16 Arctic Wildlife Range or some other major and permanent  
17 sort of transgression of that wild character of the  
18 land, then I think that the likelihood of releasing  
19 the land for oil and gas exploratory drilling is  
20 rather slight.

21 THE COMMISSIONER: But if  
22 contrary to the wishes of the State of Alaska, the  
23 Arctic Gas Pipeline were built either along the  
24 coast or through the mountains to the Canadian  
25 border, then it might well be that drilling would be  
26 allowed within the range and you might have a  
27 fundamental change in the status of the range, is that  
28 the other side of the coin?

29 A Yes, that is correct.  
30 The reason is that the -- by definition, the character



Parker, Weedon  
Cross-Exam by Marshall

1 of wilderness would have been lost by the building  
2 of the gas pipeline, therefore it couldn't be lost  
3 a second time by leasing for oil and gas --

4 THE COMMISSIONER: Or a third  
5 or a fourth.

6 A Or a third or a fourth.

7 MR. MARSHALL:

8 Q Sir, just to get back  
9 to a term you used, "capital 'W' wilderness", I  
10 understand that that is a term that under the United  
11 States legislation has a specific meaning, a Wilderness  
12 area, is a specifically defined area?

13 A That is correct.

14 Q And the Range is not  
15 a Wilderness area?

16 A That is right.

17 Q And I take it that  
18 the points that you were making was that were it  
19 a wilderness area, oil and gas exploration would not  
20 be allowed?

21 A Yes.

22 Q Given the present status  
23 of the Range, though, I take it, it is in a less  
24 protected state, if you like?

25 A Yes.

26 Q And with the permission  
27 of the Secretary who has responsibility for the  
28 Range, overall responsibility, oil and gas exploration  
29 can proceed?

30 A Yes, and I believe this





Parker, Weedon  
Cross-Exam by Marshall

1 is the case only if a positive action is taken by  
2 the Secretary to classify lands within the Range  
3 so that they are available at that point for oil  
4 and gas exploration and development.

5 Q It would, as I understand  
6 it, take some act from the Secretary?

7 A Yes.

8 Q But as matters presently  
9 stand, such activities, indeed the construction of  
10 the gas pipelines are not prohibited by law through  
11 a Range?

12 A That is right.  
13  
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Weedon & Parker  
Cross-Exam by Marshall

1 Q Onto page 7464, you  
2 were telling us where Kaktovik is. You say it's right  
3 almost at the Canadian border, it's not, is it, sir?  
4 I understand it's 80 miles from the border.

5 A Yes. By northern  
6 measurements, that's not a very great distance.

7 Q It depends on whether  
8 you're walking, I suppose. You say further on in  
9 the page:

10 "Thus, we don't know right at the moment what  
11 effect any of the proposed Alaskan Arctic  
12 Gas Pipeline Company routes would have on land  
13 use planning by the Kaktovik people."  
14 I was wondering, sir, whether you have been involved  
15 in all the meetings with the people in Kaktovik about  
16 the proposal?

17 A No, I have not.

18 Q I was wondering further  
19 if you were aware that Arctic Gas has had continuous  
20 dialogue with that community? They are, I am instruc-  
21 ted, very happy at the prospect of a pipeline and would  
22 if anything like it closer to the community. Do you know  
23 anything about that -- the people of Kaktovik?

24 A I was not aware that the  
25 people of Kaktovik were deleriously happy over the  
26 pipeline.

27 MR. MARSHALL: Perhaps you  
28 should talk to them.

29 MR. SCOTT: Who did you sand  
30 Mr. Marshall? Mr. Williams or Mr. Horte?



Weedon & Parker  
Cross-Exam by Marshall

1 That doesn't require a response, as far as I'm con-  
2 cerned.

3 MR. MARSHALL: You won't get  
4 one.

5 Q Getting back for a moment  
6 to the status of the range, as I understand it under  
7 the law, as it applies to the range, hunting is permitted.

8 A Yes.

9 Q Does the state control  
10 this?

11 A Yes.

12 Q I am told that caribou  
13 are hunted in the range.

14 A Yes.

15 Q And this is allowed all  
16 year around.

17 A Yes.

18 Q Have you any idea, sir,  
19 from the records of the State how many hunters do hunt  
20 in the range on a yearly basis?

21 A I cannot cite you good  
22 figures. The bulk of the range is still inaccessible  
23 to hunters for any great distance, unless they have  
24 enough money to fly in and can find a suitable place  
25 to land and so on, and intercept the caribou. By and  
26 large, the season is opened in this year-around condition  
27 so that it is legal to hunt at any time of the year  
28 so that when and if the native people from Kaktovik  
29 or elsewhere wish to take caribou, they can do so.

30 Q I take it others are free



Weedon & Parker  
Cross-Exam by Marshall

1 to go in there as well?

2 A Yes.

3 Q Provided they have the  
4 money.

5 A Yes.

6 WITNESS PARKER: Mr. Commis-  
7 sioner?

8 THE COMMISSIONER: Yes sir?

9 A Having been involved in  
10 the development of those regulations in the past, the  
11 is a gratuitous comment that we do many things with  
12 our subsistence regulations such as this unlimited  
13 season, and no bag limit on caribou on the North Slope  
14 only because it is difficult of access; but were it  
15 easy of access of course we would not be allowed to  
16 have that type of subsistence regulation.

17 MR. MARSHALL: It's not meant  
18 as a gratuitous comment, sir. I'm just trying to find  
19 out what the status is of the range at the moment.

20 WITNESS WEEDON: Mr. Commissioner,  
21 I might also mention that counsel probably knows the  
22 State of Alaska, through its Department of Fish & Game  
23 can set the seasons and bag limits for the harvesting  
24 of any animal there in the Arctic Wildlife Range.  
25 However, the Federal land manager, the United States  
26 Fish & Wildlife Service, can exert its own effect on  
27 hunting seasons through regulating the trespass or  
28 access to the land, because they are the landowners,  
29 so that by limiting, for example, the number of sites  
30 at which an airplane can land, or the number of camping





Weedon & Parker  
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1 places that are open, they can limit the number of  
2 people who can fly into the area to take caribou, even  
3 though the season is open continuously and with no  
4 bag limit.

5 MR. MARSHALL: Q Sir, turning  
6 to page 7467 of the transcript, you mention at lines  
7 15, 16, that there is no comprehensive land use plan  
8 in existence for gathering lines and pump stations  
9 for Prudhoe Bay, Kemik or Kavik fields, or for the  
10 connection -- interconnections of those fields.  
11 Is this an area that you have some responsibility  
12 for, Dr. Weedon, in your office?

13 A I do not have respon-  
14 sibility for the sort of physical layout of the oil  
15 field or gas field facilities as such; but I do have  
16 responsibility for overall planning, land use planning  
17 included in the State of Alaska, and one of the  
18 responsibilities is to be aware of any such regional  
19 plans that might have been made by North Slope Borough  
20 or the Alaska Division of Lands or some other planning  
21 entity.

22 Q So comprehensive land  
23 use planning in the Prudhoe Bay area would fall under  
24 your overall jurisdiction?

25 A No, the North Slope  
26 Borough has the responsibility for land use planning  
27 within the borough. However, that borough also includes  
28 a large area of state lands, obviously the Prudhoe Bay  
29 field being among them, and any comprehensive land  
30 use plan for that area would have to be mutually



Weedon & Parker  
Cross-Exam by Marshall

1 agreed to by the State of Alaska, Department of  
2 Natural Resources, and the North Slope Borough.

3 Q I was wondering, sir, if  
4 you know why there had been no comprehensive land use  
5 plan drawn up?

6 WITNESS PARKER: Mr. Commis-  
7 sioner?

8 THE COMMISSIONER: Yes, Mr.  
9 Parker?

10 A Prudhoe Bay field is  
11 operated under a unit type concept which is monitored  
12 by the Division of Oil & Gas, and for the Prudhoe Bay  
13 field itself that is very carefully regulated. How-  
14 ever the other two fields referred to, Kemik and  
15 Kavik, are outside of the field of the unit plan.  
16 Therefore, since there's been no application for  
17 production from any wells from those areas, of course  
18 no plan has been drawn up.

19 Q You said that you were  
20 getting ready to appear before the Federal Power  
21 Commission to discuss these questions. Do you know  
22 when those matters will be coming up before the Federal  
23 Power Commission?

24 WITNESS WEEDON:

25 A No, I do not. I don't  
26 have the schedule of appearance.

27 WITNESS PARKER: The last word  
28 we had was to be ready for December 12th.

29 Q Sorry, to be ready when?

30 A The last word I had was  
to be ready December 12th.



Weedon & Parker  
Cross-Exam by Marshall

THE COMMISSIONER: I see.

MR. MARSHALL: Q Sir, onto --  
you're making a note of that, are you, sir?

THE COMMISSIONER: No, I'm  
telling Mr. Gamble to make a note of it.

MR. MARSHALL: Q Turning on  
to page 7468 of the transcript, you discuss the  
assumption of there being significant deposits of oil  
and gas discovered in the Marsh Creek anticline and  
Eastern Beaufort Sea, and you go on to discuss the  
gathering facilities that would have to be constructed.  
I was wondering whether or not there was any report  
that you're relying on in support of the statement about  
the required facilities and their scale? You mentioned  
these developments would be on a scale comparable to  
Prudhoe Bay, depending on the ultimate size of the new  
fields. I was wondering what it is you rely on in  
support of those statements?

WITNESS WEEDON: The citation  
for the estimated speculative reserves of 2.7 billion  
barrels, etc. on 7468, comes from the State of Alaska  
Department of Natural Resources Open File Report No.  
50 from the Division of Geological and Geophysical  
Surveys.

Q What about your comments  
as to the need to construct an extensive system of  
gathering lines, and you further comment about this  
scale being comparable to that of Prudhoe Bay?

A What's your question?  
Where do I get that information, is that your question?



Weedon & Parker  
Cross-Exam by Marshall

Q Yes sir.

A It's from talking with  
the Commissioner of the Department of Natural Resources,  
Mr. Guy Martin, who in looking at the possibilities in  
that Marsh Creek anticline, and looking at the specula-  
ted reserves, is just making assumptions about what  
kind of facilities would be required to gather up the  
resources from that area and transport them southward.





Parker, Weedon  
Cross-Exam by Marshall

1 Q Further on in the page, sir, that is 7468, you  
2 make the statement:

3 "Accordingly the proposed pipeline would  
4 adversely affect land use planning within  
5 the Arctic National Wildlife Range and as  
6 worst case conditions could result from  
7 severe losses of Porcupine Caribou herd,  
8 converting its traditional calving area to an  
9 interconnected maze of wells, feeder lines,  
10 processing plants, pump stations and housing  
11 facilities."

12 Now, sir, it just wasn't clear to me what it is you  
13 were talking about. I take it you are not simply  
14 talking about the Arctic Gas proposal. You are  
15 talking about another--

16 A That is correct. It is  
17 going back to the point that you asked about earlier,  
18 the so-called triggering effect of the crossing of the  
19 Arctic Wildlife Range by the Arctic Gas proposed  
20 gas line.

21 THE COMMISSIONER: Once you  
22 open the door to the oil and gas industry, to enter the  
23 Arctic National Wildlife Range, if you allow them  
24 to build a gas pipeline that will create, enhance:  
25 exploration and drilling activity, presumably, and  
26 you are saying that in the Marsh Fork area you will  
27 wind up with another Prudhoe Bay field or you could.

28 A We don't know what is  
29 there, and in fact if nothing were found, then the  
30 development would be minimal, but if the estimates of



1 the State geologists are close and there is a major  
2 reserve there, then obviously there would be major  
3 activity on the surface to get it out.

4 MR. MARSHALL:

5 Q Well, there are two  
6 points really, Dr. Weedon, the first is that no one  
7 really knows whether there are or whether there are  
8 not reserves, so we are all speculating in that  
9 area.

10 The second is as to what  
11 development would follow upon that. Now, you talk about  
12 worst case conditions resulting in severe losses --  
13 I should correct that, and as a worst case conditions  
14 could result in severe losses of the Porcupine  
15 Caribou herd, converting its traditional calving area  
16 to an interconnected maze and so on, I was wondering  
17 what you based that statement on, sir. To begin  
18 with, what studies have you done which show what the  
19 effect might be on caribou of various industrial  
20 development activities, of the type that you have in  
21 mind in this statement?

22 A I have done none.

23 Q Are you relying on  
24 anything in making this statement?

25 A Yes, I am relying on  
26 both the behavioural studies and the projections or  
27 possibilities that are raised by the biologists who  
28 have looked at this rather closely.

29 Q And who are those  
30 biologists and which are the studies, sir?



A      Biologists for the  
State of Alaska who have studied this situation  
in the Prudhoe Bay area in the days of debate over  
the TransAlaska Oil Pipeline, and they would include  
Mr. James Hemming, now no longer with the State,  
but working for the Bureau of Land Management, I  
believe -- well, the Joint Fish and Wildlife Team  
on the TransAlaska Oil Pipeline surveillance team,  
and including Mr. Jack Lentfer, who is a biologist  
with the Federal Government in Alaska, including  
Dr. Klein, who is K.L.E.I.N., Dr. David Klein, who  
is from the University of Alaska in the Co-operative  
Wildlife Research Unit. He is the leader of the  
Co-Operative Wildlife Research Unit.

18 A Dr. Klein has written  
19 several publications. I cannot cite them now. One  
20 of them appeared in the Polar Record. Another one of  
21 them appeared, I believe, in the journal, Biological  
22 Conservation. I can certainly find the citations  
23 for you from Dr. Klein and there are many reports  
24 written for the -- by the Department of Fish and  
25 Game that report on the activities that they have  
26 conducted under both federal and state funding in  
27 years past in that area.

28 Q Sir, is it your evidence  
29 that the references you have just cited support the  
30 statement that I have quoted from page 7468 of your



Parker, Weedon  
Cross-Exam by Marshall

1 evidence and as a worst case conditions could result  
2 in severe losses of the Porcupine Caribou herd  
3 converting its traditional calving area to an  
4 interconnected maze of wells, feeder lines, etc?

5 A Yes.

6 THE COMMISSIONER: Yes, sir.

7 WITNESS PARKER:

8 A If I could further  
9 substantiate that. Dr. Klein has spent intensive  
10 time in Lapland and Northern Norway studying the  
11 effects of the road systems there upon reindeer.  
12 Jim Hemming has spent, so far as I know, the only  
13 American with background in caribou to be able  
14 to study the effects of the Soviet pipelines upon  
15 reindeer migration. Jack Lentfer has spent a  
16 good part of his working life on the North Slope  
17 while primarily in polar bear, he certainly learned  
18 a great deal about caribou in the process also.  
19 The point I am trying to make is that we did not  
20 arrive at these conclusions easily. You know, we are  
21 not dealing with insubstantive myths. We are  
22 very worried about what the effect of further major  
23 developments on the North Slope will be upon the  
24 Porcupine herd. It gets back to some of the  
25 discussions that went on in Whitehorse as to incremental  
26 effects of development upon wildlife populations.

27 MR. MARSHALL:

28 Q Dr. Weedon, I wonder if  
29 you could tell us which of these gentlemen that you  
30 referred to specifically did disturbance studies in







Parker, Weedon  
Cross-Exam by Marshall

1 caribou?

2 WITNESS WEEDON:

3 A Dr. David Klein was  
4 the supervisor of a study done a couple of years  
5 ago by Ken Childs at Prudhoe Bay dealing with the  
6 test section of oil line, that is a 48" mock up  
7 of an oil line in which they did some studies of the  
8 behavioural responses of caribou to that sort of  
9 a barrier in the Prudhoe Bay area.

10 Q That is the only one,  
11 is it, sir, that you are aware of?

12 A There are other --  
13 that is the only experimental study in Alaska, other  
14 than the one in the Seward Peninsula in the Nome  
15 area in which they tried to carry the experiment  
16 in the Prudhoe Bay another step farther by using  
17 reindeer herds and herding them so as to approach a  
18 section of pipeline and tressel.

19 Q Sir, in the consideration  
20 that has been given to the impact of developments on  
21 caribou, have you had regard to the work that has  
22 been done by consultants to Arctic Gas in this field?

23 A I personally have  
24 not. I am sure that all of those people that I cited  
25 have been very much aware of that work.

26 WITNESS PARKER:

27 A Mr. Commissioner --

28 THE COMMISSIONER: Yes, Mr.  
29 Parker.

30 A When the Arctic Gas group



Parker, Weedon  
Cross-Exam by Marshall

1 was working out of Arctic Village, I had intensive  
2 contact with -- well, we just talked about it over  
3 the dinner table, why, I was able to get some of  
4 their observations firsthand as they first brought  
5 them in from the field.

6 THES COMMISSIONER: Could  
7 I just ask you something. You have said that you  
8 are concerned about the impact that a major development  
9 within the Marsh Fork area would have on the  
10 Porcupine Caribou herd, that is, to use Dr. Weedon's  
11 expression, you are fearful there would be losses, perhaps  
12 severe losses to the herd. On the other hand if you  
13 do not allow exploration and drilling in the Arctic  
14 National Wildlife Range, then you will not ever  
15 recover the oil and gas, if it is as considerable  
16 as Prudhoe Bay, lying within the range. That is a  
17 tradeoff that the State has decided upon, that is  
18 what has occurred, has it?

19 WITNESS WEEDON:

20 A That obviously is  
21 putting it too simplistically. It says we'll forego  
22 any amount of oil and gas in order to save or pro-  
23 spectively save a portion of a caribou herd. All I  
24 am saying is that this is one of the factors that  
25 we have thrown into the equation and I, you know, I  
26 stand firmly by that because the caribou are valuable  
27 resources for the state, and in fact for Canada as  
28 well, and we feel that all possible steps should  
29 be taken to protect them. One of the possible  
30 steps is simply not to build a pipeline across their  
main range.



Parker, Weedon  
Cross-Exam by Marshall

WITNESS PARKER:

A Mr. Commissioner.

What we are seeking is what necessary design standards we must impose, if necessary, to do both, and right now, at the present there are not enough gathering lines installed at the Prudhoe field to get a firm reading on what effect the gathering line system will have there. But everyone, I think, is convinced that the herd must be able to get down into the relatively fly free areas during the summer. They must be able to get the benefit of the coastal winds if they are going to survive in the long term. The Prudhoe area was one of the favourite summering areas and probably we are going to have a good test case there, but we simply don't have enough experience with the Prudhoe field as it eventually will be to make any kind of determination yet, as to whether it will really block the caribou from that area. Obviously they run all over the field right now, a point which is made constantly, but there aren't that many gathering lines installed yet, so we don't know ultimately what the result will be.



Weedon & Parker  
Cross-Exam by Marshall

1 Q Next point, sir.

2 THE COMMISSIONER: I saw three  
3 of them running around the field when I was there.

4 MR. MARSHALL: Perhaps we'll  
5 call you as a witness in the environmental phase.

6 Q In any event, Dr. Weedon  
7 I take it the statement that appears at the bottom of  
8 page 7468 is putting forward what you consider to be  
9 worst case conditions, as you say in line 27.

10 WITNESS WEEDON: Yes.

11 Q And that would be the sit-  
12 uation if there were <sup>very</sup> extensive development, indeed  
13 development on a scale equal to that of Prudhoe Bay?

14 A Yes.

15 Q And as matters presently  
16 stand, that's in the area of speculation?

17 A That's right.

18 THE COMMISSIONER: At any rate,  
19 your priority is the caribou herd, so far as the  
20 area within the Arctic National Wildlife Range is  
21 concerned, the herd comes ahead of oil and gas produc-  
22 tion.

23 A As long as we have  
24 alternatives, and I think we also say that at the top  
25 of our priorities is not only the caribou themselves  
26 but the wilderness area which they are a part of, and  
27 I think I've made that point.

28 MR. SCOTT: Mr. Commissioner,  
29 perhaps it's wrong to interrupt except that I have the  
30 point in my mind now. How is it that -- how does Dr.





Weedon & Parker  
Cross-Exam by Marshall

1 Weedon's worst case prediction -- and I understand it's  
2 no more than a prediction --

3 THE COMMISSIONER: It's not  
4 even that.

5 MR SCOTT: -- on the North Slope  
6 square with what Commissioner Parker has said about not  
7 being able to draw any conclusions about Prudhoe Bay?  
8 How do they stand together those two statements?

9 WITNESS PARKER: I would like  
10 to answer that. It's a matter that we have leased that  
11 Prudhoe Bay, we have made commitments to the industry  
12 which must be fulfilled. It's a matter of how much  
13 you are committing at one time without being sure of  
14 your design standards. I would not care to see the  
15 entire North Slope developed under a design standard  
16 which would eventually be unsatisfactory for caribou  
17 migration. I'm willing to take a gamble on that portion  
18 which is encompassed by the present Prudhoe Bay field.  
19 I'd like the opportunity to observe several caribou  
20 migrations in that particular area under the present  
21 design standards before we had to make a major commit-  
22 ment of that size elsewhere. I think that's what I  
23 was trying to get across.

24 THE COMMISSIONER: If I may,  
25 I thought that you were saying that once you have a  
26 complete system of gathering lines installed at Prudhoe  
27 Bay you'd like to see then whether the caribou migra-  
28 tion is hindered substantially before you allow any  
29 further development to go ahead.

30 A Yes, any further very



Weedon & Parker  
Cross-Exam by Marshall

1 large-scale development, exactly.

2 I want to make it clear we  
3 are referring at this time primarily to the gathering  
4 lines which are a separate case from the major trunk  
5 lines.

6 MR. MARSHALL: Q The gathering  
7 lines, Commissioner Parker, would, I take it, be above  
8 ground, would they?

9 A Insofar as present  
10 standards, they are above ground, yes.

11 Q Of course, with the Arctic  
12 Gas proposal, we're dealing with a buried gas pipeline.

13 A Yes.

14 Q Sir, on page 7469 you  
15 state near the top of the page -- this is Dr. Weedon's  
16 evidence:

17 "In summary, the impact of the proposed prime  
18 route is considered to be severe and adverse  
19 since it commits land uses in the absence of  
20 a comprehensive statewide or regional plan. "

21 I was just wondering, sir, how long the state has been  
22 working on the development of the plan in the region  
23 that we're concerned with in the North Slope and Prudhoe  
24 Bay east?

25 WITNESS WEEDON: As far as I  
26 know, the state was not working on such a plan  
27 prior to the change of administration in December and  
28 I know that I personally have been working on such a  
29 plan since that time.

30 Q I take it the state had



Weedon & Parker  
Cross-Exam by Marshall

1 know of the proposal of Arctic Gas to cross the  
2 Wildlife Range for quite a number of years. That would  
3 take you back to the previous administration.

4 A Yes.

5 Q Do I understand correctly  
6 then that no planning work was done until the present  
7 governor took office?

8 A I think the key word there  
9 is "comprehensive", Mr. Marshall. You could certainly  
10 forgive any executive leader five and ten years ago for  
11 not fully realizing the implications of what seemed at  
12 that time to be very specific actions. I think we have  
13 a fuller comprehension of the entire range of possibility  
14 now for oil and gas and other developments in the north,  
15 which lead us to place a much higher emphasis on compre-  
16 hensive land use planning than ever before. So it's  
17 not with an intent to fault the previous administration,  
18 simply to say that the perceptions of need have  
19 changed very drastically in the last year.

20 Q Well, sir, one of the  
21 reasons I raise it is that those who were in regular  
22 attendance at the Inquiry know that the time schedules  
23 keep slipping, and as I understand it, the construction  
24 activities that Arctic Gas would propose for Alaska  
25 would be perhaps some five years off. I was wondering  
26 whether or not that didn't provide sufficient lead time  
27 to enable the state to get on with its planning and  
28 get it completed well in advance of any possible  
29 construction.

30 A It would. The problem is





Weedon & Parker  
Cross-Exam by Marshall

1 that there are several participants in this planning  
2 process because the Federal Government is a landowner  
3 and resource owner, and would have to concur in a  
4 number of basic decisions before the state could go  
5 ahead with its own regional planning. Likewise, the  
6 North Slope Borough has a planning responsibility, and  
7 it too would have to concur. I'm referring for  
8 example to the very different planning scenario that  
9 you could construct if you made an assumption on the  
10 one hand that the Arctic Gas Pipeline going across the  
11 North Slope of the Wildlife Range were to be built  
12 without the addition of a permanent road surface, and  
13 that, despite the fact that the gas line were built in  
14 that area, that no other step were taken to open the  
15 area to further oil and gas development. If that were  
16 the assumptions that everyone agreed to, including the  
17 federal landowners, then there would be time to plan on  
18 that basis within this period you mention.

19 But it's getting that kind of  
20 a commitment from governments of three different levels,  
21 with three different perceptions of what's good and  
22 proper and right. That is what takes the time. I can't  
23 say whether or not we would -- whether the five years  
24 would be adequate in that case.

25 Q But dealing with the  
26 application that has been filed by Alaskan Arctic Gas in the  
27 United States, I'm taking that as a base upon which to  
28 work, there would be sufficient time for the state  
29 to complete its planning?

30 A Yes.





Weedon & Parker  
Cross-Exam by Marshall

1 Q Sir, on page 7469 of your  
2 evidence --

3 THE COMMISSIONER: Excuse me,  
4 it isn't just because you haven't got your land use  
5 planning ready. Correct me if I'm wrong, but you said  
6 that the impact of the proposed prime route -- that  
7 is the Arctic Gas Route along the North Slope to the  
8 Canadian border -- is considered to be severe. Does that  
9 statement stand on its own?

10 A Yes, severe in terms of  
11 the choices you have available for land uses.

12 Q Well, you go on to say:  
13 "The proposed pipeline invades the only remaining  
14 large area on the Alaskan Arctic coast where  
15 human activities are not already pronounced, or  
16 where land use commitments have not already been  
17 made which will increase activity."  
18 That's -- is that the reason why you describe it as  
19 severe?

20 A Yes.

21 WITNESS PARKER: Mr. Commis-  
22 sioner?

23 THE COMMISSIONER: Yes, Mr.  
24 Parker?

25 A Yes, I think the  
26 statement has to be weighed against our previous  
27 testimony that there is an existing transportation  
28 corridor where the land commitment has been made, and  
29 of course that is one of the primary factors in the  
30 State taking the position it has taken.



Weedon & Parker  
Cross-Exam by Marshall

1 THE COMMISSIONER: The energy  
2 corridor from Prudhoe Bay to Valdez?

3 A Yes.

4 MR. MARSHALL: Q Dr. Weedon,  
5 just turning with the statement on page 7469, turning  
6 to that statement that the Commissioner read, I am  
7 instructed that west of Prudhoe Bay there is a large  
8 area of the Alaskan Arctic coast where human activities  
9 are not already pronounced and the land use commitments  
10 have not already been made. Is that generally true?

11 WITNESS WEEDON: What area?

12 Q The area west of Prudhoe  
13 Bay along the coast.

14 A There is a commitment  
15 in the form of a petroleum reserve No. 4 of some 23  
16 million acres.

17 Q Is there any development  
18 in that reserve at all, sir?

19 A There has been exploration  
20 for oil and gas since about 1935.

21 Q There is no development  
22 there, there is no production there at the moment?

23 A That's right. One gas  
24 well that supplies gas to Barrow, if I'm not mistaken,  
25 Commissioner Parker.

26 WITNESS PARKER: Yes.

27 THE COMMISSIONER: Well  
28 there may not be any development in petroleum reserve  
29 No. 4, but hasn't the President said, that he wants to  
30 open it up to production.

A Yes, there is a commitment



Weedon & Parker  
Cross-Exam by Marshall

1 on the part of the United States Navy, which has the  
2 authority over the sub-surface resources, a commitment  
3 to a fairly massive 10-year program of oil and gas  
4 exploration.  
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1 THE COMMISSIONER: Commissioner,  
2 Parker.

3 WITNESS PARKER:

4 A Yes, Commissioner, there  
5 have been funds appropriated, I believe in the sum  
6 of 20 million for initial exploration and Congress  
7 is considering amounts in the neighbourhood of  
8 \$200 million to begin that ten year exploration  
9 program, and it is extremely active and the Navy  
10 has begun to mobilize for an exploration program in the  
11 near future in Petroleum Reserve Four.

12 MR. MARSHALL:

13 Q Dr. Weedon, turning on  
14 to page 7470 of your evidence you are talking about  
15 the coastal or prime route and you comment at line  
16 21 to 23:

17 "It intersects all of the river and streams  
18 between Prudhoe Bay and the Canadian border."  
19 I was just wondering, sir, whether or not you were  
20 aware that the construction plan would see these  
21 crossings being done during the winter when most  
22 of these streams would be frozen to the bottom?

23 WITNESS WEEDON:

24 A Yes, I was aware of  
25 that.

26 Q And were you aware as  
27 well, sir, that the fish overwintering areas have been  
28 identified?

29 A I was aware that a lot  
30 of work had been done. I don't know whether all of the





1 areas have been identified, but I presume that most  
2 of them have, because they are so limited at least  
3 in the fresh water areas.

4 Q Yes, I understand that  
5 they are very limited and it is relatively easy there-  
6 fore to route the lines so as to avoid those areas.

7 That being the case, sir,  
8 I was wondering what you thought the impact would be  
9 of crossing these streams?

10 A This would be an area  
11 of testimony that I am really not competent to answer  
12 but it would hinge on two basic questions. One is  
13 would it in fact be possible for the applicant to  
14 construct, as proposed, that is, not constructing at  
15 all while there is water in the stream and constructing  
16 in the course of just one winter.

17 Secondly, it hinges also  
18 on the question of the longer term effects, if any  
19 of the crossing itself on the stream. Would the  
20 pipeline or any pad become a barrier to the natural  
21 flow of water. These are the sorts of questions that  
22 the hydrologists and physical scientists, not I, should  
23 address. I am sure that they have addressed them  
24 and will address them.

25 Q Well, I think you told  
26 us that you feel that this is not an area that you  
27 are competent to get into.

28 A Yes, that is right.

29 Q So I will leave it at  
30 that.



Sir, on page 7471 you have a comment at lines 7 to 9, that the pipeline would pass from zones of solid permafrost to permafrost free areas innumerable times. I was wondering, sir, whether or not you were concerned about an impact there and if so, what impact?

A I would have to answer in the same way that I did before again. It is not an area that I have any personal competence in . Nevertheless, and I will defer to Commissioner Parker, but it is obvious that when, as has been abundantly clear, throughout the testimony so far, I think, that when the temperature relationships of the pipeline itself with the surrounding soil are critical, when you change that relationship on a mile by mile or even yard by yard basis in the construction of the pipeline, then there is a clear effect on the way an engineer approaches the problem of putting the line there safely.

Q       What I am really trying to ascertain through many of these questions, Dr. Weedon, is whether or not it is something that you know about or whether you are serving a spokesman's role.

A      Serving a spokesman's  
role.

Q I see, now, specifically --well, perhaps we will move onto the next point, it is along the same line.

WITNESS PARKER: Mr. Commissioner.



Parker, Weedon  
Cross-exam by Marshall

1 THE COMMISSIONER: Yes, Mr.  
2 Parker.

3 A On that particular  
4 point we do have it under study by the soil engineers and  
5 the geologists in both the state pipeline office  
6 and my office and we will have a good deal of  
7 further dialogue, I am sure, with any proponent of  
8 a buried gas line in this particular area long  
9 before any permit is issued across state lines.

10 MR. MARSHALL:

11 Q I was wondering, Com-  
12 missioner Parker, whether the work of the engineers  
13 that you spoke of has proceeded to the point where  
14 they have produced any reports or studies?

15 A No, but they will be  
16 forthcoming shortly.

17 THE COMMISSIONER: Frost  
18 heave is an abiding interest of ours at this Inquiry  
19 and we will look forward to seeing what they come  
20 up with. That is the problem that we have been told  
21 exists here at this passage.

22 A Yes, Commissioner, it  
23 was identified by Interior as a problem and I am  
24 sure that, you know, they have some of the finest  
25 people in the world to work on this and the same  
26 people who worked on the Alyeska hot oil pipeline  
27 problems will be addressing themselves to this  
28 problem also.

29 MR. MARSHALL:

30 Q Dr. Weedon, following



Parker, Weedon  
Cross-exam by Marshall

1 up your last comment, near the bottom of page 7471  
2 you deal with modifications of the heat balance and  
3 the effect on causing degradation to the permafrost  
4 layer. Do I take it that that is another subject  
5 that is out of your particular discipline?

6 WITNESS WEEDON:

7 A Yes, that entire first  
8 several lines beginning on line 19, " All disturbances  
9 ...." etc., is a reference on pages 217 to 226 of  
10 the Environmental Impact Statement, Part 2, Volume I,  
11 pages 217 to 226.

12 Q Just on that point, I  
13 think you mentioned, perhaps it was in Whitehorse or  
14 perhaps just inside when you were talking to me or  
15 Mr. Anthony, myself or the Commissioner, after the  
16 last hearing; do you have references for your  
17 evidence to specific papers and studies and so on  
18 and different pages in the E.I.S.?

19 A I have a number of them  
20 written in marginal notes here and I would be glad  
21 to go over them with you either right now totally  
22 through the whole testimony or as we come across them.

23 Q We might get together  
24 with Mr. Anthony at the break on this point, sir. I  
25 might expedite things a little bit.

26 MR. ANTHONY: Mr. Commissioner,  
27 I should make that clear. What I asked Mr. Weedon and  
28 Mr. Parker to do was to footnote their evidence in  
29 the event that they wanted more particular information  
30 that is the form that the evidence is available.





Parker, Weedon  
Cross-exam by Marshall

1 I would think that the references could come out as  
2 questioning goes on or merely that those footnotes  
3 could be provided following the hearing.

4 MR. MARSHALL: Well, that  
5 is fine, with me, sir, we can proceed in this  
6 same manner.

7 Q Sir, over on to page  
8 7472 you comment at lines one to three:

9 "Disturbances from the Brooks Range north  
10 will be slow to revegetate naturally because  
11 of the short growing season."

12 Have you found that reference?

13 A Yes.

14 Q I was wondering, sir,  
15 what it was that you based this statement on.

16 A Knowledge of botanists  
17 about the growth rates of vegetation there and in  
18 the tundra regions in the north and experimental  
19 evidence, I guess not experiments by design, but  
20 the evidence of many years of crossing of tundra  
21 by track vehicles which left a large number of  
22 bare areas, some of which are still bare after 40  
23 years.

24 Q Now, sir, you mentioned  
25 discussions with botanists. I was wondering if you  
26 had reports or studies on this subject.

27 A Oh, I would be very  
28 surprised, although I don't have this particular  
29 point referenced, I would be very surprised if the  
30 draft environmental statement didn't go into that in



Parker, Weedon  
Cross-Exam by Marshall

1 some detail and I know that Dr. Lesly Viereck of the  
2 Forest Sciences Laboratory in Fairbanks undertook  
3 to compile a lot of these references for the  
4 Department of Interior. He was a member of this  
5 gas pipeline study group that I referred to earlier.

6 WITNESS APRKER: Commissioner.

7 A The State pipeline office  
8 when I was working there, of course had a heavy  
9 involvement in rehabilitation. When we inherited  
10 the project as it stood at the first of the year,  
11 1974, why we had to go with the work that had been  
12 done previously. We relied very heavily on observations  
13 of the Gas Arctic Test Plot at Prudhoe Bay for north  
14 of the Brooks Range observations, and unfortunately  
15 there were no test plots in dry tundra or alpine  
16 tundra.

17 To remedy this we are  
18 in co-operation with the tundra Biome program of  
19 the International Biological Program undertaking  
20 some studies of the upland tundras. It is going  
21 to be some time, I am sure, before we have any  
22 results because of the well known slow growth rates  
23 in these particular areas. It is our conclusion  
24 at this time based on present results that it will  
25 take a long time to revegetate in these areas with  
26 natural ground cover, so we are probably going to  
27 go ahead and revegetate with exotics in the hope of  
28 establishing initial erosion control and hope that  
29 we can set up a regime where the natural ground  
30 cover will take over from the exotics through the  
years. We don't know whether they will, owe and



Weedon & Parker  
Cross-Exam by Marshall

two, we don't know how long it will take yet.

Q I was wondering, Commissioner Parker, whether in considering this matter you had regard to the revegetation work that's been done by Northern Engineering Services for Arctic Gas, also work that was done by Dr. Mitchell at the University of Alaska for Arctic Gas?

WITNESS PARKER: Mr. Commissioner, yes, Dr. Mitchell's work is the basis for a good deal of the on-going work that's going on because his work started in 1968, I think. He went to work on contract to Alyeska in addition to his usual duties at the university, and has carried forward with it from that date.

I have not had an opportunity to observe the Inuvik plot through the years as closely as the Prudhoe plot. All I've done is go look at it, but I haven't been able to make any judgmental decisions based on it.

Q I was wondering, Commissioner Parker, whether you were aware that Arctic Gas and its consultants have had a program involving the reseedling of the abandoned rig sites through the Mackenzie Delta?

A Mr. Commissioner, yes, I was aware of the program, but we've never had the opportunity to get any particular benefit from that program yet. We have our own research and I'm glad for Mr. Marshall reminding me, and we'll take some steps to do so.

THE COMMISSIONER: What did you



Weedon & Parker  
Cross-Exam by Marshall

1 say, Abandoned what?

2 A Sites, rig sites.

3 THE COMMISSIONER: Oh, abandoned  
4 rig sites, yes.

5 MR. MARSHALL: And I believe  
6 there is also work done at an abandoned Hercules air  
7 strips. We'll, I think, be hearing something of this  
8 in the later phases.

9 Q Sir, also on page 7472  
10 there is a reference to thermal erosion along the  
11 Arctic coast, and I was just wondering whether or not  
12 in your view this would have any relevance to the  
13 proposed Arctic Gas Pipeline? Or is this just intended  
14 as background?

WITNESS WEEDEN:

15 A Unless the pipeline were  
16 to be built very close to the shore, no.

17 It has  
18 been suggested, at least, that the pipeline be built  
19 very close to the actual shore line.

20 MR. MARSHALL: The application  
21 as filed, will see the pipeline built some distance  
22 from the shore line, is that not so?

23 A Yes.

24 Q Sir, on page 7473 you  
25 speak of the anticipated reduction in the depth of the  
26 active layer. You say:

27 "The anticipated change in the depth of the  
28 active layer over the pipeline will be as  
29 much as 1 1/2 feet, with the gas temperature  
30 of about 12 degrees Fahrenheit."





Weedon & Parker

Cross-Exam by Marshall

A This is a citation from

Q Do you know what it was

A      No, I do not.

Q I take it that it would

A     No, I would not.

Q There is also a reference

A Previously, specifically

Q I was looking at page

A Yes, I see the reference

Q Yes, that's right. What

A Well, it seems to me

the ultimate operating temperature

t, as far as I know that

utes.



Weedon & Parker  
Cross-Exam by Marshall

1 Q My instructions, sir, are  
2 that those temperatures have been specified in  
3 Exhibits G-1 and G-2 of the Federal Power Commission  
4 filing.

5 A I'm not familiar with  
6 them. Who were they? Who tabled the exhibits?

7 Q Alaskan Arctic Gas, it's  
8 part of their application.

9 A Were they not available  
10 when the environmental impact statement was written?

11 Q Well, sir, is this your  
12 statement or is this from the draft --

13 A From the draft E.I.S.

14 Q It is, so it's something  
15 that you don't know about.

16 A That's right.

17 Q And I take it the comment  
18 about the size of the frost bulb came from the draft  
19 environment impact statement as well.

20 A Yes.

21 Q And also the comment  
22 about the depth of the active layer?

23 A On lines 12 and 13?

24 Q Yes sir.

25 A Yes.

26 Q Do you know the basis  
27 upon which these various statements have been made,  
28 what reports have been prepared, what studies have  
29 been done, sir?

30 A Unless they are cited



Weedon & Parker  
Cross-Exam by Marshall

1 there, in the text of the Environmental Impact Statement,  
2 no.

3 Q The next question I have  
4 relates to evidence given at page 7474, you're speaking  
5 about polar bears and you say in lines 1 to 3:

6 "In addition, several areas, generally at or  
7 within 25 miles of the coast have been found  
8 recently to be preferred sites for polar bear  
9 dens."

10 Have you found the reference, sir?

11 A Yes.

12 Q I believe there was some  
13 discussion on this point in Whitehorse, and I was  
14 wondering whether or not that still remains your  
15 opinion, sir.

16 A As of the last word that  
17 I have, yes, and my most recent source of that is from  
18 Jack Lentfer and I spoke with him approximately  
19 three months ago while we were preparing the draft of  
20 the Beaufort Sea, The Environmental Assessment For  
21 The Beaufort Sea Near-shore Petroleum Leasing Report  
22 which I have tabled and it's now Exhibit No. 183.  
23 It's a little more than three months ago, it's about  
24 five months ago now.

25 THE COMMISSIONER: Well, at  
26 any rate, Dr. Banfield, a witness for Arctic Gas,  
27 said at Whitehorse that it was natural for polar  
28 bears to establish their dens off-shore, so that  
29 if development activity, to use your words, drove  
30 polar bears to off-shore dens, there's nothing wrong



Weedon & Parker  
Cross-Exam by Marshall

1 with that because, that's where they would den in the  
2 ordinary course of events anyway.

3 That was a criticism that  
4 was made.

5 A I see. Did he explain  
6 why they came offshore in the first place?

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Parker, Weedon  
Cross-Exam by Marshall

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MR. MARSHALL:

Q We didn't have time  
that week, sir.

THE COMMISSIONER: I didn't  
think so. Yes, Mr. Parker.

WITNESS PARKER:

A Mr. Commssioner, I  
really suggest however, that Jack Lentfer's recent work  
in this area be examined and he did present a paper  
at the 1973 International Wildlife biologist  
convention in Stockholm at which addressed several  
of these points. I am not sure if he has published  
anything more recently or not, but the whole  
concept of polar bear migrations in the Western Arctic  
has been his domain for some time and he -- it is  
his best judgment, as Dr. Weedon just said, that our  
relationships between onshore and offshore activities  
of the polar bear have not really been well under-  
stood until they started getting some of their  
recent migration studies in.

Q Well, sir, we maybe  
have a little more recent information in fact, it  
hasn't yet been published, it is in print. My in-  
formation is that studies were conducted by Arctic  
Gas or its consultants in co-operation with the  
United States Fish and Wildlife Service in 1974 and  
1975. These involved Mr. Jack Lentfer, who  
participated in these studies as well as the  
firm of Renewable Resources who are the mammals



Parker, Weedon  
Cross-Exam by Marshall

I am  
consultants to Arctic Gas, instructed that they  
found three dens in 1974, and no dens in 1975  
inland and it is concluded in this report that the  
area traversed by the pipeline across the North  
Slope is not an important denning area for polar  
bear. That report, sir, I am instructed, will be  
in a Biological Report series and you no doubt  
will be receiving a copy of it.

MR. ANTHONY: Mr. Commissioner,  
I was going to say that that evidence or that  
report is also going to be led-- I think there  
will be some evidence led on this in the environmental  
phase. It may be conflicting and I think perhaps  
the best we can do now is say that the conflicting  
evidence is in now and it will be discussed in more  
detail at that phase.

THE COMMISSIONER: You wanted  
to add something, Mr. Parker.

WITNESS PARKER:

A. Normally I would say  
that three years is a little flimsy basis on which  
to construct polar bear migration theory, so I will  
be interested in seeing that report too.

MR. SCOTT: Did I understand  
Mr. Marshall to say that he was going to call  
Mr. Lentfer? Has he participated in the study?

MR. MARSHALL: No, you  
didn't understand me to say that, sir, I said  
that he participated in a study that was a joint  
study sponsored by Arctic Gas and the United States



Parker, Weedon  
Cross-Exam by Marshall

1 Fish and Wildlife Service and that the report is  
2 being produced as a result of the work that was  
3 carried out and it will be published in the Biological  
4 Report Series and it is in press --

5 MR. SCOTT: As he perhaps  
6 is the expert on whom both the panel and Arctic  
7 Gas appear to rely, it may be that Arctic Gas will  
8 want to call him so that his evidence can be given  
9 fresh, and the issue resolved.

10 MR. MARSHALL: I will get  
11 some instructions on that, Mr. Commissioner;

12 THE COMMISSIONER: Yes, Mr.  
13 Parker.

14 WITNESS PARKER.  
A I would only add to that  
15 that in regard to three dens in 1974, no dens in  
16 1975, one of our early jokes on the pipeline when  
17 we were surveying the first pipeline construction  
18 was that if Alyeska did anything, why, we would  
19 look into the river and say, "Um, we don't see  
20 any fish, they must have killed them all."

21 MR. SCOTT: How do you deal  
22 with that, Mr. Marshall?

23 MR. MARSHALL: I go on to  
24 my next point.

25 Q Just before leaving  
26 this point, sir, I wonder if there are specific  
27 references that you rely upon in support of this  
28 statement that might be made available to me. My  
29 advisors are interested in this point obviously and  
30 we would like to follow up on it, and specifically



1 I am dealing with the first three lines on page  
2 7474.

3 Moving on down that page a  
4 statement is made starting at line 12:

5 "The environmental concerns for the prime  
6 route will vary considerably depending  
7 on whether or not the route can be  
8 constructed in a single winter season as  
9 the proposal intends."

10 I was wondering if this could be so, Dr. Weedon, as  
11 my understanding was that pipeline construction starts  
12 in a particular point and moves on. They don't  
13 revisit areas that have already been constructed, it is  
14 a matter of starting at one end and moving along  
15 until you complete it, so impacts would be in one  
16 area at one time and then the spread would pass on .

17 MR. ANTHONY:

18 I am sorry, I don't  
19 know if I understand the question. I don't know  
20 if Dr. Weedon does. Would my friend please explain the  
21 thrust of his question so that I can understand  
22 also?

23 MR. MARSHALL: The statement  
24 is made at page 7474 that, "the environmental concerns  
25 for the prime route vary considerably depending on  
26 whether the route is constructed in one year or  
27 two years," and I was wondering why this is felt to be  
28 the case, as I had always understood that the pipeline  
29 construction started at the one end and moved on down  
30 the line and the spread didn't come back, say in the  
second year to where it had been in the previous





Parker, Weedon  
Cross\_exam by Marshall

1 year.

2 WITNESS WEEDON:

3 A I think I understand the  
4 question and I would answer it in part this way.  
5 If you start at one end and build as you go, you  
6 have to continue traversing that area which you  
7 have already built in order to bring supplies in  
8 to the head of the track, as it were, so that the  
9 disturbance, if there is any from the use of the  
10 road and the activity would continue over more  
11 than one season over the extent of the line. It is  
12 not just at the point where the next joint of pipe  
13 is to be laid that the activity is concentrated  
14 Secondly I would also say that in terms of the  
15 thermal questions that have been raised to  
16 me in conversation with people, if the pipe is to  
17 be left in the ground, empty, over several years, in-  
18 stead of only over a few months, then, or one  
19 year or something, then the longer it lies there  
20 active and the longer, the greater the possibility  
21 is for a thawing of the frozen soil in which the  
22 pipeline lays.

23 Q You may have some  
24 sort of appreciation then for why Arctic Gas chose to  
25 go to a one year construction schedule?

26 A Yes, I do.

27 Q But in answer, to the  
28 main point, I take it that you assume that, say,  
29 if they started --

30 THE COMMISSIONER: Well, a  
minute ago I thought it didn't make any difference, Mr. Marshall.



Weedon & Parker  
Cross-Exam by Marshall

MR. MARSHALL: Mr. Commissioner?

A minute ago I thought you said it didn't make any difference, and now you credit Mr. Weedon with some appreciation of your concern.

Yes, Mr. Parker?

WITNESS PARKER: I'm not sure this point has been adequately explored because in order for the gas to be refrigerated, the entire gas line must be constructed, and while the schedule is one year in Alaska, and this is the termination, I think, what Dr. Weedon is saying is that it must be some guarantee that the pipe will be refrigerated before it goes through its first thaw cycle. I don't really think that this is built into your construction schedules, Mr. Marshall. We went over this point very clearly with Alyeska, in relationship to their welding procedures, because they were trying to convince us that welding at 20 below was all right because the pipe would be heated, until we pointed out to them that they'd be moving a good many welds around probably at temperatures of 60 and 70 below. If you are basing your whole theory of burial on the point that it is going to be refrigerated almost immediately, well you're going to have to have some extremely sophisticated construction schedules because you are going to have to have -- be out and off the tundra by the middle of May, and probably should have gas in your pipe somewhere around the middle of August in order to have it refrigerated and to eliminate subsidance and general thermokarstine along the line.



Weedon & Parker  
Cross-Exam by Marshall

1 At least that's the way it seems to me at the moment,  
2 based on what you've just said.

3 MR. MARSHALL: There are several  
4 points, sir --

5 THE COMMISSIONER: Excuse me.  
6 Maybe we should stop a few minutes for coffee, and  
7 I take it, Mr. Scott, that certainly to accommodate  
8 Commissioner Parker and Dr. Weedon, we ought to sit  
9 this evening so that their evidence might be concluded  
10 this evening. If they wish to they could then leave  
11 tomorrow. Would that be --

12 MR. SCOTT: That can be done,  
13 Mr. Commissioner.

14 THE COMMISSIONER: I'm glad  
15 to hear that. We'll adjourn for coffee.

16 (PROCEEDINGS ADJOURNED FOR FEW MINUTES)  
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1 (PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

2 THE COMMISSIONER: Well,  
3 Maybe we could come to order again.

4 MR. MARSHALL: Before  
5 moving on to the next point, this matter that I was  
6 going over with the witness is about the one or  
7 two year seasons, I think we have been quite aware  
8 of the geotechnical problem, but we weren't aware of  
9 any environmental concerns one way or the other and  
10 that is what I was interested in exploring with the  
11 witnesses.

12 Q Dr. Weedon, I would like  
13 to turn to the question of water availability on  
14 page 7475 of your transcript is where it is dealt  
15 with. You mention that Alaskan Arctic Gas Pipeline  
16 Company has not conducted specific studies that I am  
17 aware of and where this amount of water would be  
18 obtained. I am informed that the studies have been  
19 carried out, sir, and Dr. McHart has been involved  
20 in them and the reports are currently in press  
21 and that there are additional studies being undertaken  
22 in the very near future involving Dr. McHart and also  
23 the U.S. G.S., so that work in a form has been  
24 underway. The study of Dr. McHart to be made available  
25 to the state if they wish it.

26  
27 Your next point pertaining  
28 to water availability, sir, seemed to be as to when  
29 it was available and you comment on line eight that  
30 no water is available after December,





Parker, ~~Weedon~~  
Cross-Exam by Marshall

1 except at springs or at the larger lakes which  
2 do not freeze completely to the bottom.

3 I was wondering, Dr. Weedon,  
4 whether or not you are aware that under the plan  
5 of Arctic Gas for construction of the section of line  
6 in Alaska, the vast bulk of the water would be required  
7 in October and November for snow road construction.  
8 Are you aware of that, sir?

9 A Yes, I am also aware  
10 that the snow is likely to be pretty skimpy about  
11 that time.

12 Q Well, that is one of  
13 the reasons for using water in order to make snow  
14 and ice roads, but the point was were you aware  
15 that, in terms of the overall water requirement, a very  
16 large part of it is for early on in the season and  
17 the requirement would specifically be for the  
18 construction of snow or ice roads?

19 A Yes, nevertheless, the  
20 problems still exist because as far as I know you  
21 have not quantified requirements in relation to the  
22 supply and in particular in relation to the supply  
23 necessary to maintain the fish populations that are  
24 in some of these permanent water areas.

25 Q Well, that is what is  
26 in these reports, sir, but you may be interested in  
27 following up on.

28 . WITNESS PARKER:

29 A Mr. Commissioner, does  
30 Mr. Marshall have any idea when those reports will be



Parker, Weedon  
Cross-Exam by Marshall

1 available?

2 I understand probably by  
3 December. December 12th is that?

4 MR MARSHALL: I will ask  
5 to  
6 Dr. Gosen/see that a copy is sent to the commissioner.

7 THE COMMISSIONER: You will  
8 make sure that a copy is sent to Commissioner Parker?

9 A Yes. My point, being  
10 sir, that if you are taking the water early, the large  
11 bulk of the water at least, very early in the season,  
12 you would be able to get it before the rivers and  
13 lakes in the North Slope area had frozen to the  
14 bottom, you would agree with that?

15 WITNESS WEEDON:  
16 A Yes, I understand.

17 Q Sir, you say near  
18 the bottom of the page, starting at line 25:

19 "If any of the 187 million gallons of water  
20 required by the applicant was to be withdrawn  
21 from sites occupied by overwintering fish,  
22 such a withdrawal would probably result  
23 in the death of those fish and very  
24 possibly the loss of the populations using  
25 that site."

26 Have you found the reference, sir?

27 A Yes.

28 Q I suggest to you, sir,  
29 that really the consequences to the fish population  
30 would be a function of a number of factors including  
whether or not there were fish there and how many  
and where the water was taken or how much water was



Parker, Weedon  
Cross\_exam by Marshall

1 taken and the care with which it was taken. Do you  
2 not agree that all of those factors would go to  
3 determining whether or not there would be any impact  
4 on fish?

5 A I agree.

6 Q Over the page at 7476 you  
7 say that, "the effects of dewatering areas would be  
8 aggravated by siltation and erosion caused by construction  
9 activities," that's lines one to three. You touched  
10 on this earlier, sir. My information is that  
11 of some 120 streams that would be crossed, only two  
12 may not freeze to the bottom at the point it  
13 is proposed to cross them and at the time that it is  
14 proposed the crossing will be carried out. Are  
15 you aware of that, sir, or do you agree with it?

16 A Those are your studies.

17 I am not aware of them nor can I necessarily agree  
18 with them. I would ask you a question in return,  
19 however. You were very careful to say at the point  
20 where we cross them. Siltation effects can occur  
21 downstream some considerable distance. Are there  
22 more streams that would be affected under those  
23 conditions?

24 Q I guess the point that  
25 I am specifically interested in --

26 THE COMMISSIONER: Excuse me,  
27 just so I understand Dr. Weedon's point. Do you  
28 mean that the effect of siltation might well be that  
29 they wouldn't be frozen to the bottom at those points  
30 where Arctic Gas intends to cross by the time the winter  
arrives when they go ahead and build their crossing?



Weedon & Parker  
Cross-Exam by Marshall

1 Was that the point?

2 WITNESS WEEDON: As I under-  
3 stood Mr. Marshall's statement, there are, according  
4 to his figures, 120 streams that would be crossed,  
5 of which two would not be frozen to the bottom at the  
6 time and at the place when they would be crossed by  
7 the pipeline. I am simply asking the question, are  
8 there other streams which cross let's say at any time  
9 which would -- the crossing of which would cause siltation  
10 downstream from the point of crossing, which could then  
11 affect the populations over-wintering in that area, or  
12 the spawning populations?

13 MR. MARSHALL: Well sir, I can  
14 try to put the thing into perspective. I'm not sure  
15 who is the witness here at the moment.

16 A I'm trying to understand  
17 your question.

18 Q I'll ask Dr. Weedon whe-  
19 ther or not he thinks that there is any problem caused  
20 by siltation of the stream, if the stream is crossed  
21 at a time when it was frozen to the bottom?

22 A It would depend on what  
23 happens after breakup next spring.

24 Q Well, sir, if there were  
25 any siltation at all during the spring breakup, would  
26 it not, in your experience, be insignificant relative  
27 to the siltation naturally occurring at breakup time?

28 A I'm not sure because  
29 that would depend on the type of the stream that was  
30 being crossed. If it were a stream naturally carrying





Weedon & Parker  
Cross-Exam by Marshall

1 a heavy silt load at breakup, or heavy particulate  
2 load, then probably no change.

3 Q I take it that you haven't  
4 done any work in this area and there is nothing that  
5 you can specifically refer me to?

6 A These comments on the  
7 effects of stream crossings are taken from the draft  
8 Environmental Impact Statement, and I can cite you a  
9 number of cases where these sorts of problems were  
10 alluded to in that statement. I would be glad to, if  
11 you would like.

12 Q We have copies of the  
13 draft Environmental Impact Statement, sir. Dr. Dawson  
14 has the various references. Now, sir, you deal in your  
15 evidence at page 7476 with the caribou herd, Porcupine  
16 herd. You say at the beginning of line 16:

17 "Increased access to a caribou herd and increased  
18 human activity have historically had adverse  
19 impacts on caribou and reindeer herds wherever  
20 they are found. There is no reason to expect  
21 the activities associated with the proposed  
22 Alaskan Arctic Gas Pipeline project will have  
23 any less impact."

24 That's the end of the quote, sir. I was wondering first  
25 what historic activities you had in mind in this  
26 statement, or is this another statement that is borrowed  
27 from the draft Environmental Impact Statement?

28 A Well, I'm sure it occurs  
29 there, although that's not a specific reference.  
30 In Alaska at least, and I believe elsewhere, there is



Weedon & Parker  
Cross-Exam by Marshall

1 ample evidence of an association of increased human  
2 activity and increased access to a caribou range with  
3 these adverse effects on the caribou or reindeer  
4 herds, wherein those areas. I'll cite for example  
5 the effects of hunting, the effects of tracked vehicles  
6 and snow machines on the behaviour of caribou, the  
7 effects of improper use of helicopters, and use of  
8 large numbers of noise-making machines including  
9 compressors and pumps on the ground, as well as air-  
10 craft in the air, all of which are known and can  
11 observably be seen to have effects on the lives of  
12 caribou and reindeer.

13 Q Well, sir, your descrip-  
14 tion of those various activities leads me to the next  
15 question. In listing those various activities, do I  
16 take it that you're assuming that all of those are  
17 going to follow the construction of the Arctic Gas  
18 Pipeline?

19 A I think that most of them  
20 will. It's certainly within the power of the state  
21 government, to, for example close the season on caribou  
22 and thus make it impossible for hunters to hunt along  
23 the line. Nevertheless, that then forfeits access to  
24 a resource of some significance, and there are people  
25 who wish to have access to those caribou, and it's  
26 sometimes very difficult for governments to decide  
27 to shut off that access to such a resource.

28 Now as far as the other  
29 activities are concerned, the non-hunting activities,  
30 I think you would agree that if my initial apprehension



Weedon & Parker  
Cross-Exam by Marshall

1 which I voiced very early comes to pass, that is that  
2 the construction of the gas pipeline across the North  
3 Slope of the Brooks Range does -- is in fact followed  
4 by increased human activity, then this activity will  
5 have an effect on the caribou that are up there.

6 Q You agree, do you  
7 personally, sir, that hunting is an activity that the  
8 state can control in this area, if it chooses to do  
9 so?

10 A Yes, within the limits  
11 of the budgetary ability of the state to put enforce-  
12 ment officers up there to enforce the laws.

13 Q And your concern then,  
14 if I understand you correctly, is more with the  
15 developments that you anticipate might follow rather  
16 than with the project of Arctic Gas?

17 A Yes, and I say,  
18 "activities associated with,"  
19 not necessarily restricted to the activities within  
20 the responsibility of the applicant company.

21 Q Well, what impact on  
22 caribou do you foresee following the activities of  
23 the applicant company alone?

24 A These would specifically  
25 stem from any facilities that were constructed along  
26 the line, such as compressor facilities. They would  
27 also flow from or result from the maintenance activities  
28 of the pipeline and those compressor stations.

29 Q Sir, in those regards  
30 have you read the disturbance study work relating to



Weedon & Parker  
Cross-Exam by Marshall

1 caribou that's been done by consultants to Arctic Gas?

2 A No.

3 Q You haven't?

4 A No.

5 Q It may be of interest  
6 to you then, sir, and I say that because those distur-  
7 bance studies/dealt both with aircraft disturbance and  
8 compressor station noise, and if you follow the  
9 proceedings of the Inquiry I think you will hear  
10 evidence from the consultants who have been involved  
11 in the work, that they don't share your concern.  
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Parker, Weedon  
Cross-Exam by Marshall

1 Just to make it clear, sir,  
2 the statement then at page 7476 is made without regard  
3 to the work that has been done by Arctic Gas and  
4 is reported in the Biological Report Series on  
5 caribou?

6 A I wouldn't say it is  
7 made without regard to. I would say that it is  
8 made cognizant of that work in the Biological Report  
9 series. Nevertheless the cautionary approach, the  
10 cautious approach and the apprehensions here, I think  
11 are still very well founded.

12 Q Well, sir, you haven't  
13 read the Biological Report Series reports pertaining  
14 to caribou?

15 A That is correct, but  
16 as I said early in my statement, I am relying on  
17 the judgments of many people who have read those  
18 reports.

19 Q Well, I am interested  
20 in the statement found on page 7476, line 16 to 22  
21 inclusive, whose judgment does that represent, sir?

22 A The judgments of, and I  
23 will name some of the people who I named before, Dr.  
24 David Klein, Mr. James Hemming, Dr. Robert LeResche  
25 the last being L.E.R.E.S.C.H.E. of the Alaska Department  
26 of Fish and Game.

27 WITNESS PARKER:

28 A Commissioner, I read  
29 the studies and I was in the area a good deal when  
30 they were being carried out and I think the point



1 that needs to be amplified is that that small fraternity  
2 of people who specialize in caribou behaviour are not  
3 really that unified in their judgment on this situation,  
4 while Gas Arctic's consultants have certainly  
5 spoken in this area, there is a good deal of  
6 dialogue that needs to be continued on it.

7 Q Dr. Weedon, there are  
8 a number of comments pertaining to caribou in this  
9 section of your evidence and I was wondering generally,  
10 sir, what the basis of of these comments. Was this  
11 your own work, that of your staff, or was this the  
12 work of some other agency.

13 WITNESS WEEDON:

14 A The comments are a  
15 representation of the results of the work of all of  
16 those people that I mentioned and people who have  
17 worked, who together represent the mass, the majority  
18 of expertise on caribou in Alaska, including Dr.  
19 Ronald Scoog whose work up to the middle and late  
20 1960's was the classic and foundation work for  
21 people, for biologists later on. These conclusions,  
22 which are general, that you cite here and in lines  
23 further down, 22 through 29, are, I believe, fair  
24 representations of the results of the work of those.  
25 people.

26 Q Well, sir, have they  
27 been involved in the preparation of the evidence  
28 that is found reproduced at these pages of your  
29 transcript? Or is this someone's assessment of the  
30 effect of their work?



Parker, Weedon  
Cross-Exam by Marshall

A      This is my assessment from  
the reports that they have written and from my talks  
with them as personal friends, over, in some cases,  
fifteen years.

Q This section dealing with caribou <sup>is</sup> essentially taken from the draft, "Environmental Impact Statement of the Department of the Interior?"

A I don't have every line cited here and I have a bunch of citations of -- in the page 7475 on the water problem and fish problem. I have no such citation on this material from the caribou, so I am not sure whether it appears in this form in the draft, "Environmental Impact Statement" or not.

Q You mentioned that your assessment of the work of the various scientists who have been involved in this area has been made on the basis of the reports they have written and personal conversations. I was wondering, sir, if you could list and provide the list to your counsel, the various reports that you have in mind when you make that statement.

A I will do so.

Q Thank you, sir.

You speak about the harrassment of caribou by low flying aircraft, and this is dealt with at 7477.

A Yes.

Q You have told me that you



1 are aware of the plan of Arctic Gas to carry out  
2 construction along the North Slope during the winter  
3 and you will agree with me that the caribou are  
4 absent during that time period?

5 A Yes, certainly they are  
6 not, as indicated three or four lines down, the  
7 calving time is not at that time of the year.

8 Q Do I take it then that  
9 your concern then would relate to operations and  
10 maintenance flights?

11 A Yes. That would refer  
12 not only to the operations and maintenance by the  
13 applicant or the pipeline company itself, but also  
14 by any government agencies that have occasion to  
15 go on surveillance flights along the pipeline.

16 Q I was wondering, sir, if  
17 you had been aware of the flying rules and regulations  
18 that have been issued by Arctic Gas governing all of  
19 its operations, specifically, they restrict heights  
20 at which aircraft are flown and matters of that sort?

21 A Is this operations of  
22 the prospective pipeline?

23 Q Well, at the moment it  
24 is operations of the study groups that are carrying  
25 out the --

26 A Yes.

27 Q Are you familiar with  
28 the regulations?

29 A Yes.

30 Q Are you familiar at all





1 with the disturbance studies that were done  
2 pertaining to aircraft and caribou that were in  
3 part responsible for the establishment of the altitudes?

4 A Not specifically, no.

5 MR. ANTHONY: I wonder if  
6 Mr. Marshall could assist me. Is that the report  
7 that he referred to earlier that will be provided  
8 in December or is this another report?

9 MR. MARSHALL: No, we were  
10 talking about water availability earlier. The  
11 report that I am talking about now is in the Biological  
12 Report Series. I don't have the reference now. I  
13 can get it for Mr. Anthony if he would like it.

14 Q Sir, I am not certain  
15 whether the flying rules and regulations that I have  
16 spoken of are in evidence. I believe they may be an  
17 exhibit. I don't have that reference. If not, the  
18 environmental panel, I think will speak to those  
19 and put them in.



Weedon & Parker  
Cross-Exam by Marshall

WITNESS WEEDON:

May I point out that in this discussion, and it's obvious to you, Mr. Marshall, that whatever Arctic Gas may do to control the activities of its own consultants or its own personnel or contractors, that it has no very great control at least over the air space used by photographers who might come up from Altoona, Pennsylvania to take a look at the pipeline and this kind of thing. It's the entire gamut of <sup>private</sup> governmental and corporate activities that cause me to make these statements.

Q Well, I suppose it's true, though, is it not, Dr. Weedon, that there is no control now over anyone who may wish to fly over caribou, inspect them, indeed to harass them? There's very little control being exercised by governments.

A There is a regulation prohibiting it, but there is no enforcement. Of course, the point is that until activity in the Arctic became so intense and seems likely to intensify that it became a problem, because so few people ever got up there. It's a matter of maybe a dozen overpasses a year during calving time may be tolerable by the caribou, but 100 may very well not be.

THE COMMISSIONER: Mr. Parker, you wanted to add something?

WITNESS PARKER: I'd like to get the discussion back to what the situation is now. Right now there are two weekly DC-3 flights into Kaktovik along the coastline that serves the Dew Line stations. There are three S-27 flights from



Weedon & Parker  
Cross-Exam by Marshall

1 Fairbanks and then of course there are the over-flights  
2 of the Polar Air routes which can generally not be  
3 heard, only the vapor trail seen, and they are  
4 usually 33 to 37,000; but -- and then normally the  
5 rest of the people that are in that area are either  
6 Arctic Gas or the Fish & Wildlife Service. There's  
7 very little casual intrusion into the area. The Arctic  
8 Research Lab has a camp there too, and the general  
9 aviation activity at Prudhoe Bay never extended very  
10 far east of Flaxman Island. There were a few explora-  
11 tions along the Canning and through there, but very  
12 tentative.

13 The level of activity, aviation  
14 activity on a pipeline corridor, especially in its  
15 early days before the support roads are built is  
16 very intensive, and especially helicopter activity.

17 Helicopters do tend to fly at the minimum legal  
18 altitude, and do tend to be very noisy. But in the  
19 first summer of the Alyeska construction, why when  
20 you were helicoptering along the pipeline, why you  
21 kept eyes open because sometimes you'd have two others  
22 in sight at the time, and it was a very intense level  
23 of activity. I doubt if anyone can build a major  
24 pipeline, at least in the initial stages, before he  
25 gets his ground support going without have that  
26 particular level of activity. I think that's what  
27 the whole discussion ranges about.

28 Dr. Klein has done a great  
29 deal of work on stress analysis, due to overflights of  
30 aircraft, and has some ideas of his own about this, and



Weedon & Parker  
Cross-Exam by Marshall

1 it's very difficult to quantify, based on the Alyeska  
2 experience, because I don't remember us encountering  
3 any major caribou migrations during the period of  
4 intense aviation activity, if there were n/o one has  
5 reported them as yet and I didn't have any personal  
6 experience in that regard.

7 But caribou will tend to be  
8 further east in the Gas Arctic area, and it is still  
9 very -- a subject which I said earlier, has not been  
10 resolved; but there is probably at this particular  
11 moment less aviation intrusion into that part of  
12 Alaska than any other part, except for the Aleutian  
13 chain.

14 Q Dr. Weedon, on page 7477  
15 at line 9 and following, you have a statement as  
16 follows:

17 "Disruptions of the normal movement and  
18 behaviour patterns of the Porcupine caribou  
19 herd may cause the herd to abandon part or  
20 all of the traditional calving ground with  
21 possible catastrophic effects on the popula-  
22 tion and serious secondary impacts on the  
23 wolves and humans who depend on caribou for  
24 their subsistence."

25 That's the end of the quote. I was wondering, sir,  
26 what it was that you were basing this statement on,  
27 or is it one that's taken from the materials prepared  
28 by others?

29 WITNESS WEEDON:  
Simply by transference  
30 of the experience of these people whom I cited, and





Weedon & Parker  
Cross-Exam by Marshall

1 other areas to this relatively new-- that is, yes,  
2 relatively new area as far as our knowledge is  
3 concerned. I talk about disruptions of the movement  
4 and behaviour patterns of the Porcupine herd, may  
5 cause the herd, I'm not saying that disruptions have  
6 caused the herd to abandon part or all of its range,  
7 etc.

8 MR. SCOTT: Tell Mr. Marshall  
9 "catastrophic" will be indexed under "horrendous".

10 MR. MARSHALL: Is that an  
11 undertaking that we will receive an updated index?

12 MR. SCOTT: If you'd been here  
13 on Friday you would have had a full report on the index.

14 MR. MARSHALL: I read the  
15 remarks in the transcript, Mr. Scott, and I'm eagerly  
16 awaiting pages on "horrendous". We now have two  
17 references.

18 Q Dr. Weedon, it's been  
19 pointed out to me that the statement that you make  
20 at the beginning at line 9 is essentially the statement  
21 that's made on page Roman numeral II:771 of the draft  
22 Environmental Impact Statement. Do you have the  
23 document?

24 A No, I don't have it  
25 in front of me, no.

26 Q There's no reference in  
27 the materials. Now it may be that you and the advisors  
28 who prepared the draft Environmental Impact Statement  
29 had the same thoughts in mind. Perhaps you could tell  
30 me what it's based on?



## Weedon &amp; Parker

# Cross-Exam by Marshall

A Are you saying there's

Q There's none in either.

A Yes, yes. As I said,

Q Well, sir, I would have

A I would defer to your

Q Well, do I take it

A I told you that I would



Weedon & Parker  
Cross-Exam by Marshall

1 of disturbance on the behaviour of caribou, and I will  
2 do that. I cannot do it right now.

3 THE COMMISSIONER: Yes, Mr.  
4 Parker?

5 WITNESS PARKER: Mr. Marshall,  
6 the last point I remember him addressing was, however,  
7 as to whether wolves and humans competed for caribou  
8 as a food source. Was that under dispute?

9 MR. MARSHALL: No, that's not  
10 the point I was getting at.

11 Q Your assertion that there  
12 were possible catastrophic effects in the population,  
13 and serious secondary impacts, I wanted to know what  
14 the basis of the statement was.

15 A Well, we are experienced in  
16 similar situations due to impacts in other parts of  
17 Alaska in relationship between predator and prey,  
18 specifically wolf and caribou, and human interaction,  
19 I think we can document such interactions by chapter  
20 and verse, not in this specific geographical location,  
21 but certainly in other areas of the state. Having  
22 sat through many hundreds of hours of hearings on  
23 this specific subject, why I would certainly have  
24 no doubts about the state's ability to get into that  
25 area about as deeply as we chose to.



Parker, Weedon  
Cross-Exam by Marshall

1 Q Well, I appreciate your  
2 remarks, Commissioner, Parker, but specifically, I  
3 think what we are trying to assess is what the impact  
4 of the proposal that has been advanced will be and  
5 that is what I am trying to relate the statement  
6 to. Do I take it that the statement is meant to  
7 relate to the Arctic Gas proposal, Dr. Weedon, is  
8 that fair?

9 WITNESS WEEDON:

10 A That is meant to say  
11 that there is grounds for concern that what we  
12 know is occurring and has occurred in the past in  
13 other parts of Alaska might also occur with the  
14 Porcupine Caribou herd given the increase in access  
15 and human usage of the range of that herd in the  
16 future triggered by the applicant's proposal for the  
17 their pipeline.

18 Q I take it we get back  
19 then to what you view as the triggering effect. It  
20 is not this project so much as what you see might  
21 follow specifically.

22 A I think that is accurate,  
23 yes.

24 Q Specifically you are  
25 concerned about oil and gas exploration in the range?

26 A Yes, there is that, but  
27 also the matter of sort of opening the flood gates  
28 as Justice Berger mentioned, that if you turned the  
29 Arctic Wildlife Range into a multiple use area, rather  
30 than as a potential wilderness area, then you are





Parker, Weedon  
Cross-Exam by Marshall

1 talking about the likelihood of hard mineral development  
2 as well as oil and gas development for example.

3 Q Well, as matters currently  
4 stand under American law, isn't this something that  
5 is left to the judgment of the Secretary of the  
6 Department of the Interior?

7 A That is correct, but  
8 the matter of designating the area as a wilderness is  
9 left to Congress and if the Secretary takes an  
10 action which leads to the loss of the wilderness  
11 character of the area, then the Congress no longer  
12 has that option. The Secretary can take, on his own,  
13 an action to, as you pointed out, to permit the  
14 utilization of the Arctic Wildlife Range for a  
15 gas corridor, and that action, if not stopped by  
16 Congress, would prevent Congress in the future  
17 from designating that portion of the range as a  
18 wilderness area.

19 Q Well, that would really  
20 apply to any area in the United States?

21 A That is correct, that  
22 is correct, any area that is now wild and there aren't  
23 that many.

24 Q Again, sir, later in  
25 that paragraph, line 18, you talk about the eventual  
26 disappearance of wilderness and rare species will  
27 follow/<sup>human</sup> occupation of the pipeline route. Do I take  
28 it that you are not really talking so much about the  
29 Arctic Gas proposal, which has very low human occupation  
30 in this area, but what you see is perhaps following



1 it?

2 A That is correct.

3 That was line 18 on what page?

4 Q 7478, sir, and further  
5 on the same page you deal with animal behaviour  
6 patterns being disrupted due to noise sources and the  
7 possibility of psychological stresses. You say at  
8 line 22 to 25, quote:

9 "This disturbance could conceivably result in  
10 some degree of psychological stress --

11 THE COMMISSIONER: That is  
12 physiological --

13 MR. MARSHALL:

14 Q Physiological, I am  
15 sorry. Physiological stress. Getting up for those  
16 early flights is telling on me, sir. Under which,  
17 sir?

18 THE COMMISSIONER : It is  
19 under "P", never mind. Just carry on.

20 MR. MARSHALL: Have you  
21 got that for the indexers?

22 Q You say:

23 "This disturbance could conceivably result in  
24 some degree of physiological stress and will  
25 probably at least force animals from the  
26 specified areas activity."

27 I take it there should be an "of" inserted before  
28 activity there.

29 I was wondering, sir, if this  
30 was again something that was your opinion or whether this



Parker, Weedon  
Cross-Exam by Marshall

1 is someone else's opinion?

2 A The draft, E.I.S., page  
3 657 deals with that question, and that is the  
4 citation that I am mainly relying upon.

5 Q That is the basis  
6 of your opinion, you haven't done the work yourself  
7 that leads to this statement, sir?

8 A That is right.

9 Q Turning to the bottom  
10 of page 7480, and continuing over on the page,  
11 7481, the following statement is made, quote:

12 "The proposed Alaskan Arctic Gas Pipeline  
13 system with its individual components will  
14 have a cumulative, longrange adverse impact  
15 on possible future status and productivity  
16 of the Arctic Coastal Plain and foothills  
17 areas of the Arctic National Wildlife Range  
18 as wilderness."

19 Again, sir, is this a statement of yours, or is  
20 this a statement made by others that you have  
21 adopted?

22 A I am sure others have  
23 said it, however, this is a statement of mine. I  
24 would back this statement, because -- and I am not  
25 sure what your specific problem is with it -- but if  
26 you are talking about future status and productivity,  
27 I notice that you sort of stress the word "productivity"  
28 do you wish an explanation of that or?

29 Q You are anticipating my  
30 question, I do want you to get into that and I am



Parker, Weedon  
Cross-Exam by Marshall

1 wondering what you see as being the effect on produc-  
2 tivity of the North Slope the project would have.

3 A As wilderness.

4 Q Well, perhaps I mis-  
5 understood you. I thought the -- as wilderness  
6 related to status, future status, possible future  
7 status, which you say in lines 2 and 3.

8 A No, I meant the  
9 as wilderness, the very last two words in the sentence  
10 to refer to both future status and productivity of  
11 this plains and foothills area, and wilderness is a  
12 valued human experience. It can be seen therefore as  
13 a resource and the ability of this area to produce  
14 that good for humans will be changed by the proposed  
15 project, and that is what I meant here. I didn't  
16 phrase it very well.

17 Q So the productivity --

18 A That does not relate  
19 to so many grams of carbon fixed by photosynthesis  
20 per year, etc., biological productivity.

21 Q That is what I was  
22 wondering about, thank you.

23 Would you turn, sir, to page  
24 7482, the middle of the page you make the following  
25 statement, quote:

26 "Under worst case conditions it would be  
27 possible to harm up to 60,000 Old Squaws  
28 and Eider ducks."

29 End quote. Have you found that?

30 MR. SCOTT: What page was that,





Parker, Weedon  
Cross-Exam by Marshall

1 Mr. Marshall?

2 MR. MARSHALL: 7482.

3 MR. SCOTT: Thank ;you.

4 MR. MARSHALL:

5 Q Have you found that  
6 reference?

7 A Yes.

8 Q I was wondering  
9 what you base this statement on.

10 A That comes from the  
11 State of Alaska's Beaufort Sea Report which is  
12 Exhibit number 183, tabled at this hearing and also  
13 from the Bureau of Land Managements, or the Department  
14 of the Interior, E.I.S., on page 697.

15 Q Does that figure  
16 represent the entire population of Old Squaws and  
17 Eider ducks in the region?

18 A I can't answer that. I  
19 would presume it is that portion of the population  
20 that could be exposed to spilled materials in this  
21 lagoon or esturine system of the north coast.

22 Q The State of Alaska  
23 study you were referring to was one that dealt with  
24 what, sir? - Exploration --?

25 A It dealt with the  
26 question, shall the State of Alaska lease its own  
27 lands from mean high tide out for three miles to  
28 oil and gas, that is, lands in the Beaufort Sea area.

29 Q Was the statement  
30 quoted drawn from a consideration of the consequences



1 of a major crude oil spill?

2 A Well, that was of course  
3 the prime item that might be spilled under a leasing  
4 of areas for oil and gas, and exploratory drilling and  
5 so on. However, it would refer also to any other  
6 toxic materials that might be spilled including fuels  
7 that would be used for all of the equipment, machinery  
8 for building any kind of a major facility up there  
9 including a gas pipeline. I think in that paragraph  
10 that you are referring to, on page 7482, lines 11  
11 through 15 or 14, I mention the factors that would  
12 -- as those factors change so would the nature of  
13 the damage, if any to the waterfowl.



Weedon & Parker  
Cross-Exam by Marshall

1 Q You indicated a worst  
2 case condition, and wondered if that didn't mean that  
3 you were relating it to a major oil spill? It seemed  
4 to me like it was quite a number of ducks.

5 A M-hm. Yes, I would say  
6 that the risk of a harm to that many birds would mainly  
7 hinge on, let's say, the spilling of large quantities of  
8 crude oil. That would be the only material in such  
9 huge quantities at -- in that region.

10 Q Further on in the page,  
11 sir, beginning at line 22, you say:

12 "Petroleum products entering a sub-surface  
13 drainage system may lower freezing temperatures  
14 of ground water and delay the formation of a  
15 frost bulb and threaten pipeline integrity."

16 Have you found that, sir?

17 A Yes.

18 Q Sir, I am advised that  
19 most petroleum products are immiscible in water and have  
20 little or no effect on lowering freezing points. Do you  
21 know anything about that, sir?

22 A This is a citation from  
23 the Environmental Impact Statement, Volume 1, and I  
24 'can't vouch for it one way or the other.

25 THE COMMISSIONER: What was the  
26 word you used, Mr. Marshall?

27 MR. MARSHALL: I had to ask--

28 A They don't mix.

29 MR. MARSHALL: Immiscible.  
30



Weedon & Parker  
Cross-Exam by Marshall

1 Q Sir, at pages 7482 to 89  
2 of your evidence you deal with the interior route.  
3 Do I take it, sir, that as between the coastal route  
4 and the interior route, you prefer the coastal route?

5 A Speaking from my opinions  
6 personally?

7 Q Yes sir.

8 A It's time to go to this  
9 a-b-c thing again. I recall a debate that took place  
10 in the Whitehorse hearings with Mr. Collins and Mr.  
11 Leonard, in which you were asking them to choose up  
12 sides and list these things in order of preference, and  
13 I'm not sure exactly how to deal with it myself. Each  
14 of these routes has its pro's and con's, and one is  
15 forced to look at the whole series of alternatives  
16 rather than just looking at one at a time.

17 Q Well sir, I agree, it  
18 gets quite complicated, and I was wondering if we  
19 could deal with just two of them. Arctic Gas has  
20 put forward what it calls its prime route, and then  
21 an interior route, which it is prepared to build if the  
22 coastal route, the prime route is not available. I  
23 was wondering as between those two routes, the interior  
24 route, yes, that Commissioner Parker was referring to,  
25 and the coastal route, whether you had a preference as  
26 between those two?

27 THE COMMISSIONER: If you'll  
28 remember, Dr. Weedon, that the witnesses who came from  
29 the United States, one was Mr. Collins and the other  
30 was --





Weedon & Parker  
Cross-Exam by Marshall

1 A Dr. Leonard.

2 Q -- Dr. Leonard, were  
3 choose between those two routes and they both, as I  
4 recall, preferred the coastal route. That is it would  
5 do the least damage, they felt. Now, if notwithstand-  
6 ing the State of Alaska's position, the F.P.C. and  
7 so on and so forth, we're to say, "We will let  
8 Arctic Gas build this thing." Then where would you  
9 sit? They should build it along the coast or through  
10 the interior, or have you an opinion at this stage?

11 A Well, I think that when  
12 you're asking as between those two routes, then you're  
13 really on -- or I, personally, am on the horns of a  
14 dilemma because the more southerly route in my opinion  
15 is the worse of the two, is that good grammar, anyway  
16 it's not the one I would choose from the standpoint of  
17 its effect on specific vegetational and soil and water-  
18 fowl and other wildlife resources because I think there  
19 are more resources under potential jeopardy in that  
20 more southerly route. However, that route does miss,  
21 as I understand it, the Arctic Wildlife Range, and  
22 a very prime concern, in my own personal consideration  
23 of this matter, is the integrity of the Arctic Wildlife  
24 Range as a potential wilderness area. I think this  
25 has become clear in my answer to many of these questions.  
26 So that is the dilemma that I would be faced with.

27 Do you value -- would you trade  
28 off a somewhat more harm -- potential harm to wildlife  
29 resources in order to retain the wilderness that you  
30 have available now? I would really rather not answer



Weedon & Parker  
Cross-Exam by Marshall

1 the question unless I'm forced to at the moment. I  
2 think it's enough to point out the real difficulties  
3 and I will certainly admit that, and maybe this is  
4 what Mr. Marshall is really after, that the potential  
5 damage to environment, apart from wilderness character,  
6 is less with the coastal route than the other one,  
7 the interior route.

8 MR. MARSHALL:

9 Q Doctor Weedon, I can  
10 appreciate that you agonize over the question, and that  
11 you back away from personally wanting to make a statement  
12 on it. I was wondering, though, whether or not the  
13 State has taken a position on this issue?

14 A No, it has not.

15 WITNESS PARKER: Mr. Commissioner, in the final meeting of the State Working Group  
16 we did not rank order the alternatives other than  
17 our decision for an all TransAlaskan route, and as Dr.  
18 Weedon pointed out, there are very many detrimental  
19 disadvantages to the south with the Wildlife Range  
20 route probably penetrates the area. One of the most  
21 pristine remaining wilderness areas left on the  
22 continent, however, there are very real political  
23 reasons why the state, you know, does not want to  
24 choose between those two routes because the Arctic  
25 Wildlife Range is an existing refuge and does have  
26 status now, and you don't want to give away that which  
27 you already have in the hope of future gains in other  
28 areas easily.

29 That's why we didn't rank  
30 order them.



Weedon & Parker  
Cross-Exam by Marshall

1 THE COMMISSIONER: Yes.

2 MR. MARSHALL: Q Sir, on page  
3 7508 of the transcript you make the statement, beginning  
4 at the top of the page:

5 "Gollop and Davis in studies done for the  
6 Alaskan Arctic Gas Pipeline Company found  
7 that noise similar to that made by a compressor  
8 station will eliminate snow geese from an area  
9 and would also adversely affect other molting  
10 waterfowl."

11 With respect to this area, sir, I was wondering if  
12 you had quantified it or you were aware of the area  
13 as quantified by the researchers?



1                   WITNESS WEEDON: A       That material is cited  
2 from the Environmental Impact Statement and I can give  
3 you the page numbers, page 1425, part 2, volume II.

4                   I can't recall whether that discusses the area  
5 affected or not. I would suspect that it does.

6                   Q       Dr. Weedon, I gathered  
7 from your opening comments outlining your experience  
8 that you were involved, beginning in August 1959  
9 with the Sierra Club, the Alaska Conservation Society  
10 and the Wilderness Society, is that correct?

11                   A       Yes.

12                   Q       Do I understand correctly  
13 that you were involved with these organizations as  
14 one of the principal opponents of the Alyeska project,  
15 the TransAlaska pipeline project?

16                   A       Yes.

17                   Q       What was your role in  
18 that endeavour, sir?

19                   A       At that time in August  
20 of 1969 when I went to work for those three conservation  
21 groups and until I left their employ in June of 1970  
22 that was one of the hottest periods in the debate  
23 over the TransAlaska oil pipeline and my effort at  
24 that time was to point out some of the problems that  
25 I and others of my acquaintance foresaw with respect  
26 to that oil pipeline that didn't appear to be dealt  
27 with adequately by the engineers and other people  
28 representing TransAlaska Pipeline at that time.  
29 I pointed out the potential problems of the pipeline  
30 on caribou migrations, the entire question of oil





1 field development and its impact on waterfowl and  
2 other creatures of that area, the question of the  
3 North Slope haul road and its effect on opening up  
4 the country to more human pressures and settlement,  
5 etc., basically raising the issues that I felt were  
6 not being addressed adequately on a project of that  
7 magnitude.

8 Q Did you write articles  
9 pertaining to these concerns that you had, sir?

10 A Yes, I did.

11 Q Did you also testify  
12 in the various court proceedings that were carried  
13 out?

14 A I never appeared in  
15 person to testify, I may have submitted testimony  
16 to the three groups that were in litigation through  
17 the Environmental Defence Fund. I know that I  
18 drafted testimony. I can't honestly say whether  
19 it actually appeared in the court record or not.

20 Q Yes, well, perhaps you  
21 could check that point, and if you did give evidence  
22 you could let us know.

23 A Would you like a copy of  
24 the evidence?

25 Q Yes, I am sure that it  
26 would make fascinating reading.

27 Also you mention that you  
28 wrote articles. I wonder if you would be good enough  
29 to provide us with a list of those articles that  
30 you did write



Parker, Weedon  
Cross-Exam by Marshall

1 A I will.

2 Q Sir, you mentioned that  
3 you were concerned that certain problems had not been  
4 adequately dealt with in the studies. Ultimately  
5 did you feel that the Alyeska Company and its consul-  
6 tants did adequately deal with those various concerns  
7 that you raised?

8 A I would really say  
9 that the proof of that is in the pudding and the  
10 pudding is just now being made. The person who  
11 here can speak to that more adequately than I is  
12 Commissioner Parker, that is, you are asking the  
13 question, were these problems that I and others  
14 raised adequately recognized and responded to by  
15 the TransAlaska Pipeline, or now Alyeska, and has  
16 that been put in, have those problems been responded  
17 to on the ground in the construction of the pipeline.  
18 So if you don't mind my deflecting that question  
19 to Commissioner Parker, then I would ask that you  
20 ask him.

21 Q Well, sir, I don't  
22 really want to get into a blow by blow about the  
23 Alyeska project and so on. Really, I was interested  
24 in your role more specifically, and I will tell you  
25 why, sir. I had understood that you had had a very  
26 major involvement as one of the people working very  
27 hard in opposition to the proposal, the Trans-  
28 Alaska Pipeline proposal, and you told us that you  
29 identified a number of major concerns that you felt  
30 hadn't been adequately demonstrated. I think it



1 is fair to say from your evidence, at least as I  
2 understand it, that you are here before us today  
3 saying that that same corridor ought to be the one  
4 that accommodates the gas pipeline in the event  
5 one is built, to take Prudhoe Bay gas to markets, and  
6 that leads me to ask, well, has Dr. Weedon become  
7 satisfied that all of the environmental concerns  
8 he felt should be addressed and remedied, if you  
9 like on that route, have been addressed and remedied,  
10 and that is why he feels that that is also the  
11 best route for a gas pipeline.

12 A I am certainly not  
13 going to tell you that which I don't believe is  
14 true, and that is that all of the problems have been  
15 solved, that there are no problems remaining, environ-  
16 mental problems remaining in the construction of the  
17 TransAlaska Oil Pipeline. Again, for specific  
18 problems, if you want to get into them, I think  
19 Commissioner Parker can tell you about them, but  
20 the TransAlaska Oil Pipeline is an established project  
21 that is not going to be stopped. It is going to  
22 go to completion. It has established a corridor.  
23 It has resulted in the construction of a permanent  
24 road and work pad to the North Slope and it is  
25 my conclusion and my feeling that it is best that a  
26 subsequent gas pipeline taking a resource out of the  
27 same area uses the same corridor.

28 THE COMMISSIONER: I wonder  
29 if Mr. Parker could comment on the matter that was  
30 raised.



Parker, Weedon  
Cross-exam by Marshall

WITNESS PARKER:

A Well, I am disappointed in being left out of Gas Arctic's research because I did testify at the '69 and at the '71 hearings on the oil pipeline and drafted the Alaska Conservation Society's statement at those oil pipeline hearings besides presenting my own. I also drafted an econometric analysis, at the time I was working for the Federal Field Committee for development planning in Alaska and I drafted an econometric analysis of the TransCanada route and Valdez route which proved to my satisfaction that the TransCanada route offered more economic advantages to the United States and that is all a part of the record, and that was later substantiated by Charles Chekety(?) work at resources for the future on the oil pipeline. However, that as a particular position did not prevail. The reason why I favoured the Trans Canada route environmentally was to keep the oil out of salt water, a position -- a problem which the State of Alaska is still addressing and will pursue with vigour as to tanker standards between Valdez and the west coast. So you are correct, all of the problems which were brought up at that time have not been addressed. We regard this as more the fault of the Federal Government than the fault of the State of Alaska, but we are, as I said, pursuing it vigourously.





Weedon & Parker  
Cross-Exam by Marshall

1 As Dr. Weedon stated, the oil pipeline is now a fact  
2 of history, and the prime environmental reason for  
3 favoring a trans-Alaska route is simply that that  
4 corridor does exist, that it has been co-opted for  
5 transportation uses, substantial investments have  
6 been made in infra-structure which can also serve  
7 the construction of a gas pipeline. That is the  
8 difference between 1975 and 1969-70. It is a simple  
9 fact that the decision was made for the oil pipeline  
10 and it carries environmentally with it a gas pipeline,  
11 as far as we're concerned. Plus the fact that you  
12 do not have the same problems with gas in the marine  
13 environment as you do with the transport of oil.

14 Q Commissioner Parker,  
15 may I first say that I didn't intentionally omit  
16 reference to your work involving Alyeska battles. It  
17 was purely through ignorance. I hadn't been aware of  
18 your involvement. Sir, had I been, I would have  
19 brought it up.

20 Now you say that the difference  
21 now is that it's a fact. Well, really isn't it history  
22 in the making, it's just now being constructed and  
23 we don't know what the impacts will be, do we?

24 A We know what the impacts  
25 have been thus far. We have committed substantial  
26 resources to the roads, to the camps, to all the  
27 necessary structures, and when I say "we" I mean the  
28 United States, as a nation. These are facts. There is  
29 the environmental problems of this route have been  
30 thoroughly thrashed out as far as the dock at Valdez,



Weedon & Parker  
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1 and we are still in the process, as I said, working  
2 out the salt water leg with which I am highly involved  
3 at the time. So we do have however, a good handle  
4 on what exists on shore, and whatever gas line is  
5 built, we will apply the knowledge we have gained.  
6 However, obviously we have a great deal more ground  
7 truth in the present corridor than we could possibly  
8 have in any other corridor simply because we have  
9 disturbed so much soil in that particular corridor.

10 Also the fact is that it is  
11 committed, and the other corridor is not committed for  
12 transportation uses.

13 Q Well, sir, we're talking  
14 about a section of a line of less than 200 miles across  
15 the North Slope for the Arctic Gas proposal, on the  
16 prime route.

17 A Oh yes, but that will  
18 impact the whole northwest corner of the state. It is  
19 not just a line across the map. We went through that  
20 thread across the map argument a long time ago.

21 Q Well, that I'm sure, will  
22 be debated at considerable length by the environmental  
23 witnesses being called by the various parties in the  
24 ensu\_ing phases.

25 THE COMMISSIONER: Are you  
26 suggesting the thread across the map or thread across  
27 the football field, that that isn't an apt analogy?

28 A No, I don't think  
29 especially if you look<sup>at it</sup> on the hydrographic analysis  
30 that it's an apt analogy at all.



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1 THE COMMISSIONER: Well, I  
2 didn't think it was.

3 WITNESS WEEDON: Perhaps this  
4 will not be at all helpful, but I'll say it anyway.  
5 A very thin wirepassed right through the neck will  
6 nevertheless sever the head from the shoulders.

7 (LAUGHTER)

8 MR. MARSHALL: I think that  
9 brings to mind one of the exhibits filed with the  
10 Inquiry in a community hearing.

11 THE COMMISSIONER: Well, it  
12 brings to mind it's getting close to five, and it's  
13 about this time in the afternoon that we don't seem  
14 to function as -- with as real effectiveness as we  
15 usually do. What do you suggest, Mr. Scott?

16 MR. SCOTT: Mr. Commissioner,  
17 it was hoped that we could finish the present panel  
18 tonight. I think that's unlikely, and I've suggested  
19 to Mr. Anthony that they should be our guests in  
20 beautiful downtown Yellowknife over-night and return  
21 tomorrow at nine, hopefully we will finish with them  
22 in plenty of time so that they will be able to get an  
23 early plane out in the early afternoon. Then we will  
24 have Dr. Hughes, who will be here to be cross-examined  
25 and that will be, I think, tomorrow's work.

26 MR. ANTHONY: Mr. Commissioner,  
27 the only comment I would make is that it is imperative  
28 for Commissioner Parker to return to Juneau, the state  
29 capital, for Wednesday, and provided the other counsel  
30 are agreed that he will be able to leave tomorrow



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1 evening, I have no objection -- or tomorrow afternoon.  
2 If they feel that they need more time, I would hope that  
3 could be accommodated this evening.

4 MR. SCOTT: Well, Mr. Commis-  
5 sioner, I would think that we, having canvassed the  
6 other counsel as to how long we will be, we will  
7 finish with this panel in, I would think, three hours.  
8 I haven't heard from Mr. Marshall, will Mr. Marshall  
9 deal with much more?

10 MR. MARSHALL: About a half  
11 an hour.

12 MR. SCOTT: Then if that is  
13 Mr. Marshall's estimate, and his are usually accurate,  
14 we would be finished with them by lunch. In any  
15 event, even if we're not, as they don't answer to our  
16 subpoenas, they can simply pack up their bags and  
17 leave at five o'clock, I suppose, and there's not  
18 much we can do about it. But I would think there would  
19 be no risk that they would not be on their way by  
20 shortly after lunch tomorrow.

21 MR. MARSHALL: Are we going  
22 to sit this evening, sir?

23 THE COMMISSIONER: Well, I  
24 don't think so. With that, gentlemen, and Mr. Scott  
25 says we can rely on him, we will be finished with  
26 you by noon tomorrow, that being so we might as well  
27 adjourn now and get a good night's sleep. You people  
28 have been travelling and you might prefer that.  
29 Do you have any views?  
30







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1 WITNESS WEEDON: Well, we  
2 want to you know, be available for a complete round  
3 of questioning now, and it looks as though we can do  
4 it by late afternoon tomorrow for sure. We would be  
5 also willing to come back tonight, however, if you wish.

6 MR. SCOTT: I think, Mr.  
7 Commissioner, coming back tonight is not going to allow  
8 this panel to leave tonight or first thing in the  
9 morning, and that being the consequence, we might all  
10 be shorter and brighter and more acute if we --

11 MR. MARSHALL: Thank you  
12 again, Mr. Scott.

13 MR. SCOTT: -- if we began at  
14 9. I except Mr. Marshall for that remark.

15 MR. ANTHONY: Mr. Commissioner,  
16 before we adjourn I wonder if I could just make one  
17 comment to tie the matter together, and that is Mr.  
18 Marshall asked Dr. Weedon for a list of his articles  
19 written and evidence provided the environmental  
20 litigants in the Alyeska matter. Dr. Weedon advised  
21 me he said he'd make that available. I merely comment  
22 that of course some of these may be for the purpose  
23 of litigation and we'll have to take it subject to  
24 their counsel's advice; but with that limitation we'll  
25 do what we can.

26 THE COMMISSIONER: O.K., we'll  
27 adjourn until nine o'clock in the morning then.

28 MR. SCOTT: Mr. Commissioner,  
29 just before we adjourn, so the record will be complete,  
30 in the cross-examination of Dr. Lewis at page 10762, Mr.



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1 Bayly was pursuing the question of whether Babbage  
2 Bight or Herschel Island were suitable for harbors,  
3 and Dr. Lewis referred to a report which he wanted  
4 Mr Bayly to know about. We have the report here which  
5 is the Department of PUBlic Works Report called:

6 "Herschel Island Feasibility of Marine Terminal."  
7 I will provide it to him. I don't think it's necessary  
8 to make it an exhibit unless he wants us to. I will,  
9 however, provide it to him and regard our undertaking  
10 as discharged, unless there's something else to be done  
11 about it.

12 MR. HOLLINGWORTH: This after-  
13 noon Mr. Marshall distributed a cost comparison between  
14 the Fairbanks corridor and the prime route. Now I  
15 wasn't certain at the time if it was made an exhibit.

16 THE COMMISSIONER : I think it  
17 should be, Mr. Marshall.

18 MR. MARSHALL: Fine, sir. We  
19 can file that.

20 THE COMMISSIONER: Yes, you can  
21 file that and let me have a copy too.

22 (COST COMPARISON BETWEEN FAIRBANKS CORRIDOR &  
23 PRIME ROUTE MARKED EXHIBIT 287)

24 THE COMMISSIONER: Well, we'll  
25 adjourn till nine tomorrow then.

26 (PROCEEDINGS ADJOURNED TO OCTOBER 21, 1975)  
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